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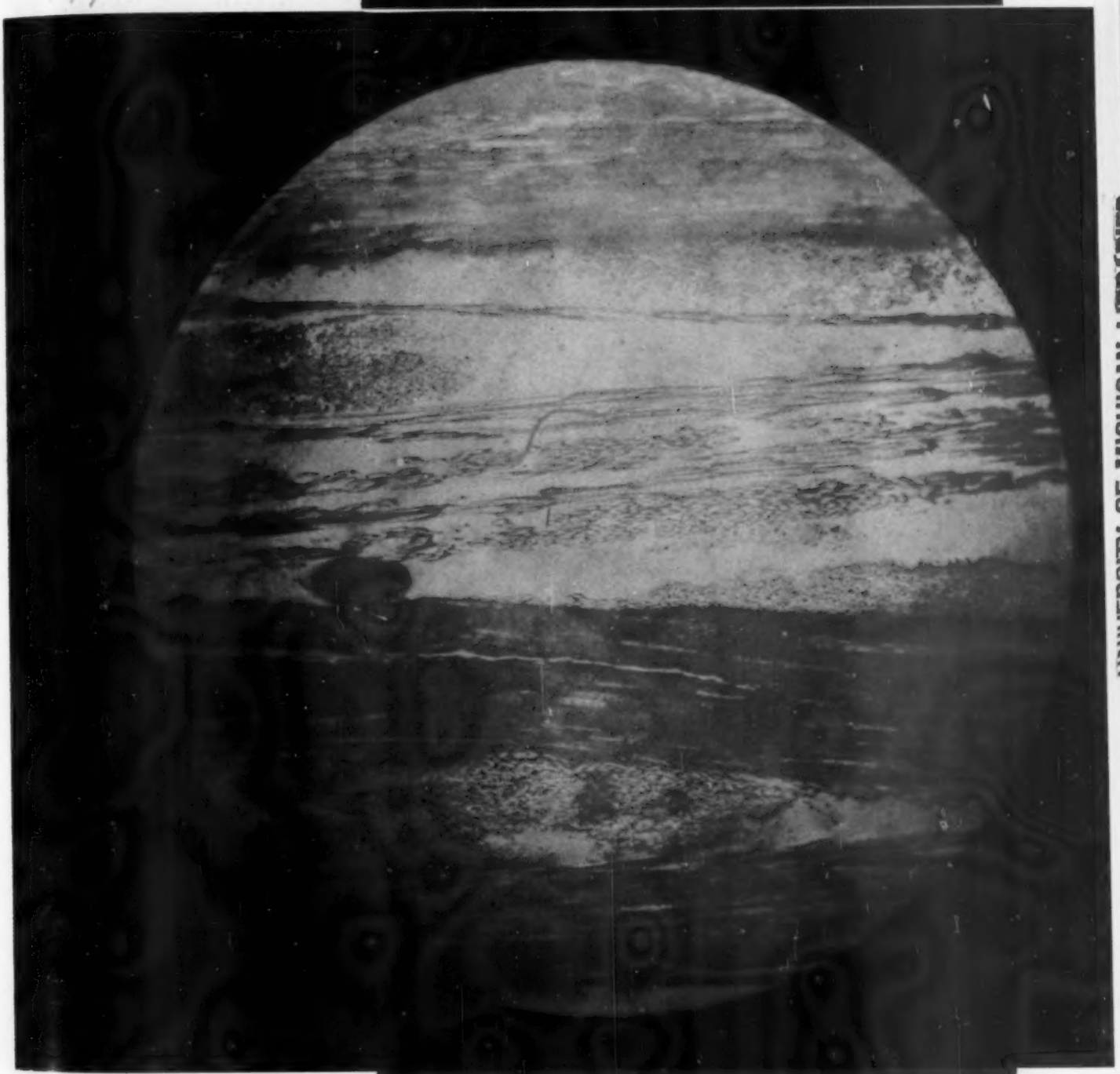

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See article by G. W. Bainton, Jr. on page 610

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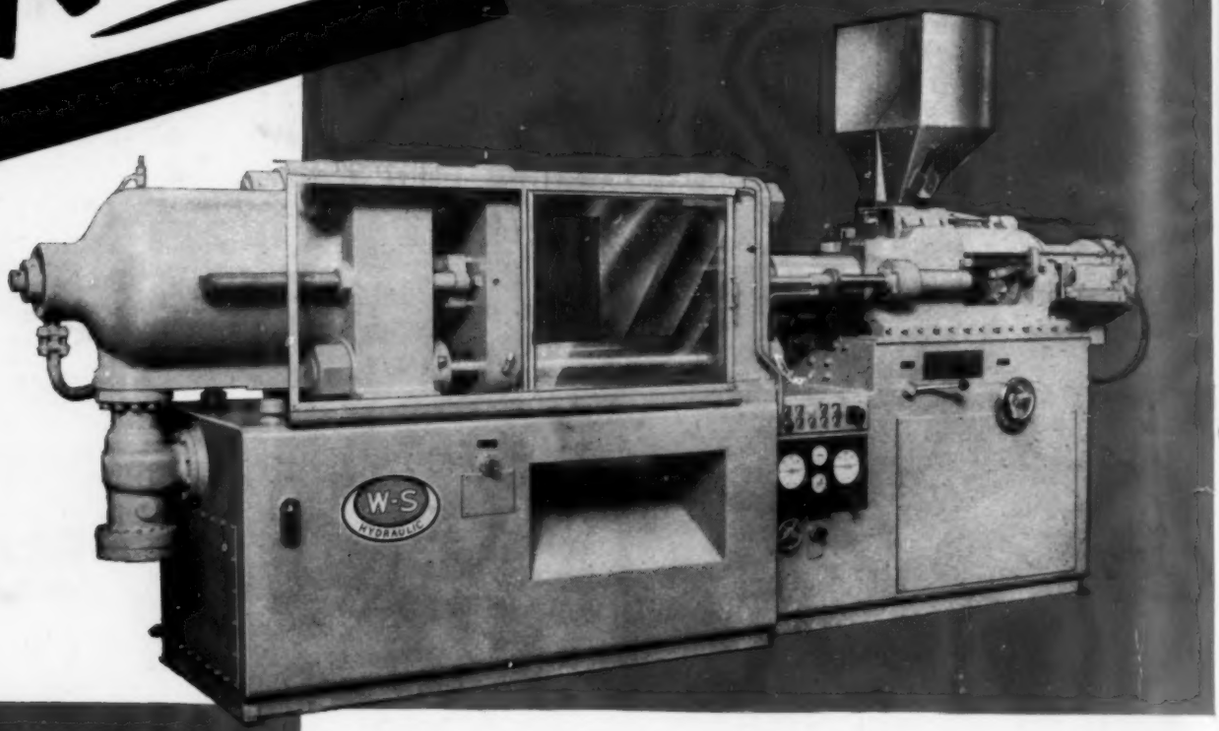

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Letters to the Editor

Dear Sir:

I have read the article "Recent Advances in Epoxy Resins" by Elliot N. Dorman in the May issue, page 213. The article appears to be very misleading and incomplete for the following reasons:

In the section on Chemistry of Hardening, the influence on curing mechanism of the use of different types of amines should be pointed out. Aliphatic amines cure epoxy resins mainly by catalytic reaction. Aromatic diamines cure epoxy resins mainly by addition reaction.

In the section on Curing Systems, liquid amine hardeners may offer a pot life as long as eight hours, instead of the 15-90 minutes mentioned in the article. The importance of amine catalyst for acid anhydride curing systems should be emphasized. Certain epoxy resin-phthalic anhydride systems will never cure completely in the absence of catalysts. The time required for gelling at 300° F. for Epon 828-phthalic anhydride (10:8) may be reduced from over 10 hours to less than 10 minutes by the addition of 1% triethanolamine.

The availability of hardeners in viscous liquid form which may be mixed with liquid epoxy resin at room temperature and give cured products with similar properties as metaphenylenediamine-cured resin was not mentioned in the article. No example of the chemical identity of liquid acid anhydride was given, although I believe that dodecyl succinic anhydride has been tried as an epoxy hardener. Examples of diluents, plasticizers, fillers, pigments, dyes, etc., were not given, and optimum resin-hardener ratios were not emphasized.

I feel that the article, in general, does not reveal enough new facts, nor is it a review of the subject.

Tung Tsang, Plastics Laboratory
Minneapolis-Honeywell Regulator Co.
Minneapolis, Minnesota

• • •

Dear Sir:

A client of mine is having difficulties in molding vinyl squeeze toys. In the process a hollow mold is used into which liquid vinyl is poured. Subsequently, the mold is placed in an oven where the vinyl is formed to the shape of the mold. However, in the process a great deal of heat and pressure are built up which cause an overflow at the clamp end of the mold. This overflow, which occurs between the open end of the mold and the clamp, is seriously tieing up production.

If you can suggest any means of releasing the air pressure that causes the overflow of vinyl in this operation, I will be very much indebted to you. I have thought of the possibility of using air vents that would be made through the clamp or mold, but am not sure this is practical.

Peter J. Farmer
New York, N. Y.

(Can our readers suggest anything to solve this problem?—Editor)

• • •

Dear Sir:

PLASTICS TECHNOLOGY is off to a good start and promises to fill a void that has existed in the literature, particularly in the field of advanced design and process technology. We, in the government, who are adapting weapons, vehicles and equipment to plastics will appreciate good coverage of the sort that you have given in the first three numbers of your magazine.

Please enter my subscription for one year to be mailed to my home address.

H. A. Perry, Consultant on
Non-Metallic Materials
Naval Ordnance Laboratory
Silver Spring, Maryland

• • •

Dear Sir:

We wish to reply to the letter from Arthur Dritz, of John Dritz & Sons, that appeared in your April issue. We are manufacturers of specialty wax products that have found wide application as a part thickness and core material for use in pattern shops, foundries, and the casting and laminating plastics industry. This material is also manufactured in sheets of any desired thickness, and we believe that we can meet all the requirements stated in Mr. Dritz's letter.

We would appreciate your either forwarding this letter to Mr. Dritz or send-

ing us his complete address so that we may contact him.

William Siegfried, Chief Chemist
The Kindt-Collins Company
Cleveland, Ohio

(The letter has been forwarded. Our thanks to Mr. Siegfried.—Editor.)

• • •

Dear Sir:

We have a problem relating to the vacuum forming of party masks from flexible vinyl sheet material. After forming, the masks must be die cut to trim the edges and cut out the necessary eye, mouth, and nostril holes. These openings are at different height levels, of course. How can all of these trimming and cutting operations be done simultaneously?

(Identity withheld)

• • •

Dear Sir:

In the April issue, on page 167, there is a report of my talk before the SPE Cleveland-Akron Section on March 14. The report points out that I cited the Chrysler heater housing as an example of a premix molding application. To prevent any misunderstanding, I want to point out that my remarks were prefaced by the unpublished comment that this information on Chrysler's application was released by Mr. E. J. Premo before the SAE meeting in Detroit on January 13.

William E. Wirsch
Rohm & Haas Co.
Philadelphia, Pa.

(Our apologies to Mr. Wirsch for the error of omission. Our correspondent did not provide the introductory remarks.—Editor)

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation, and address.

Letters requesting information on technical or engineering problems will be printed to elicit replies by the readers, either directly or through these columns. Upon request, the identities of such "problem" letters will not be divulged.

—The Editor

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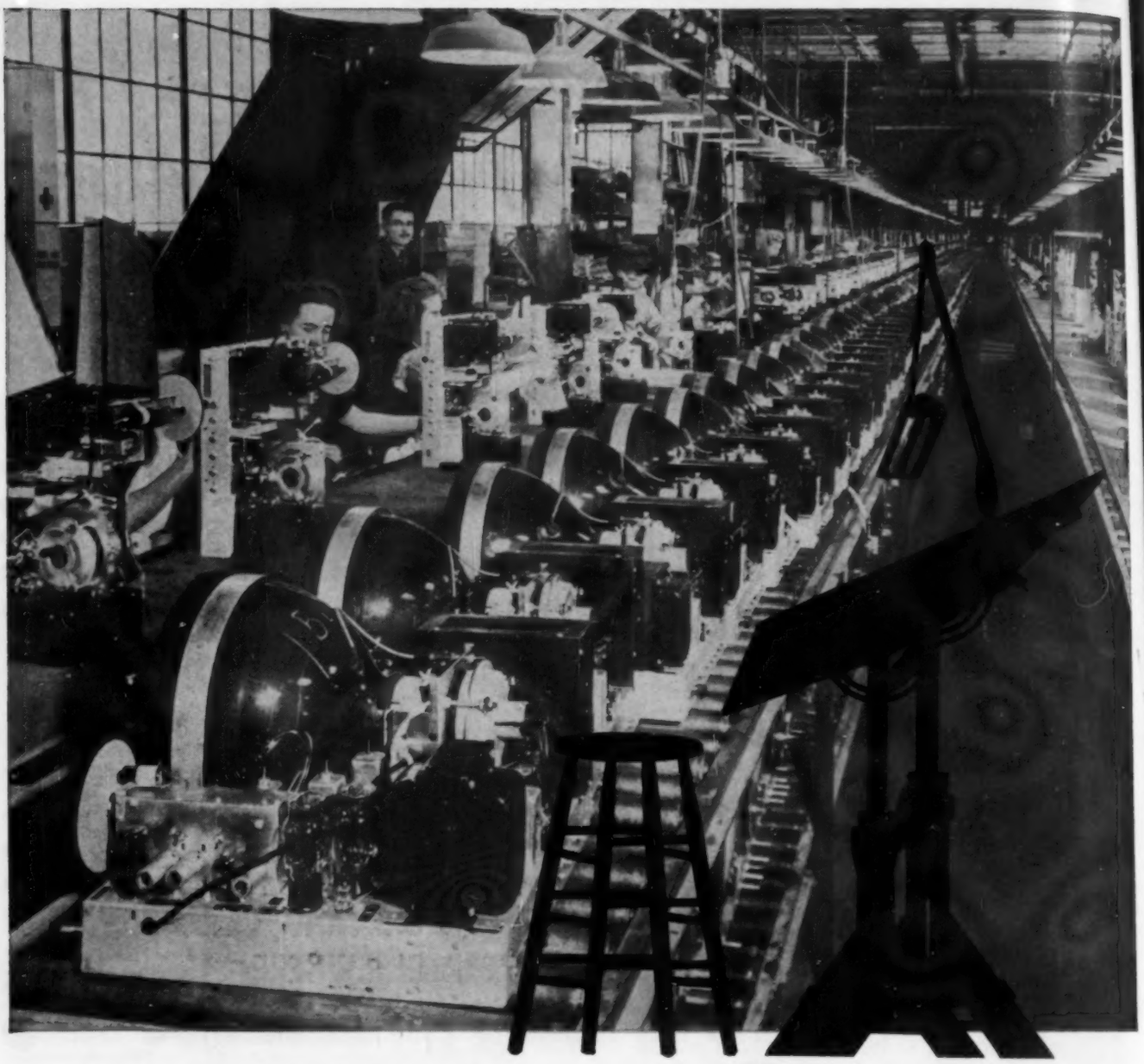

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NEWS in BRIEF

Demand for plastics will rise sharply, according to Gordon Brown, of Bakelite. Discussing the 12 basic types of plastics, Brown put 1954 production at 2,657.4 million pounds, and estimated 1960 production at 5,985.9 million pounds. Output advances will be led by vinyls, polystyrene, and polyethylene.

Three plant openings were announced during May. Spencer formally dedicated its new polyethylene plant at Orange, Tex.; a multi-million dollar facility designed to produce 45 million pounds of resin per year. The new Gibbstown, N. J., oxychemical plant of Hercules Powder will make 26 million pounds of phenol annually, as well as related products. Raffi & Swanson formally started its new coatings plant at Wilmington, Del., to make spray lacquers, vinyl gravure inks, metallizing coatings, and cements.

Polyethylene oversupply until 1957 predicted by Marsh, of National Distillers' U. S. Industrial Chemical Division (see guest editorial, page 296). New facilities either complete or well under way will raise output to 550 million pounds per year, whereas current demand is 300-350 million pounds annually. This demand will increase as new products are developed and potential properties of modified polyethylenes are more fully utilized.

Expansions in the industry continue. Cadet Chemical is building a $400,000 plant to make organic peroxide catalysts and various ketones. The productive capacity of Celanese's Pampa, Tex., plant is being doubled. This facility makes vinyl acetate,and will also produce methyl ethyl ketone. A new lab annex and a test field are being built by South Florida Test Service to meet increasing demand for material deterioration testing. New equipment at Thiokol will more than double output of plasticizers for vinyls and rubbers. A new chemical research lab will be built by Phillips Petroleum near its headquarters, Bartlesville, Okla., as an addition to the firm's research center.

PVC resin will be made by Insular Chemical, a new firm formed by two film and sheeting producers, Rose & Roberts and Rubber Corp. of America, who will take the major portion of the new company's output. For the first time, two established consumers of vinyls will secure a basic position as resin suppliers. R.C.A. will act as sales agents for Insular's overstock.

Other changes announced during the month: Standard Machinery sold its molding press business to Hull-Standard, a new and separate company, because of overtaxed facilities for producing plastics extruders and wire insulating equipment to meet industry demand. Mastic Tile has bought Wright Mfg. Co., and is now probably the world's largest producer of resilient tile flooring and wall covering. Ekco Products purchased the plastic housewares division of Kilgore whose injection molding will round out Ekco's plastics operations.

E. H. Johnson becomes a member of our Editorial Advisory Board to cover the field of plastics calendering, on which he is an authority. Johnson is executive engineer and manager of mills & calenders sales for Farrel-Birmingham, and has 39 years of service with that firm.

New Materials worthy of mention (see page 313) include polyethylene packaging film; glycol ester and polymeric plasticizers; clear cast acrylic sheet; a parting agent for bag molding; three stabilizers; two polyester resins; a fire-retardant for polyesters; and a release agent.

New Equipment of interest (see page 315): a universal stiffness tester; plastics extruders; replacement cylinders for injection machines; cartridge heating units; automatic vacuum formers; a coating calendar; and a plastics rheograph.

New Products in the news (see page 318): reinforced plastic window boxes and luggage; safety glasses; Teflon insulator terminals; rigid vinyl wall coverings; polyethylene drum faucets; laminated vinyl handbags; butyrate spinner heads for lawn sprinklers; polyethylene friction catches for cabinet doors; disposable polyethylene syringes; and Tenite insulator bushings.

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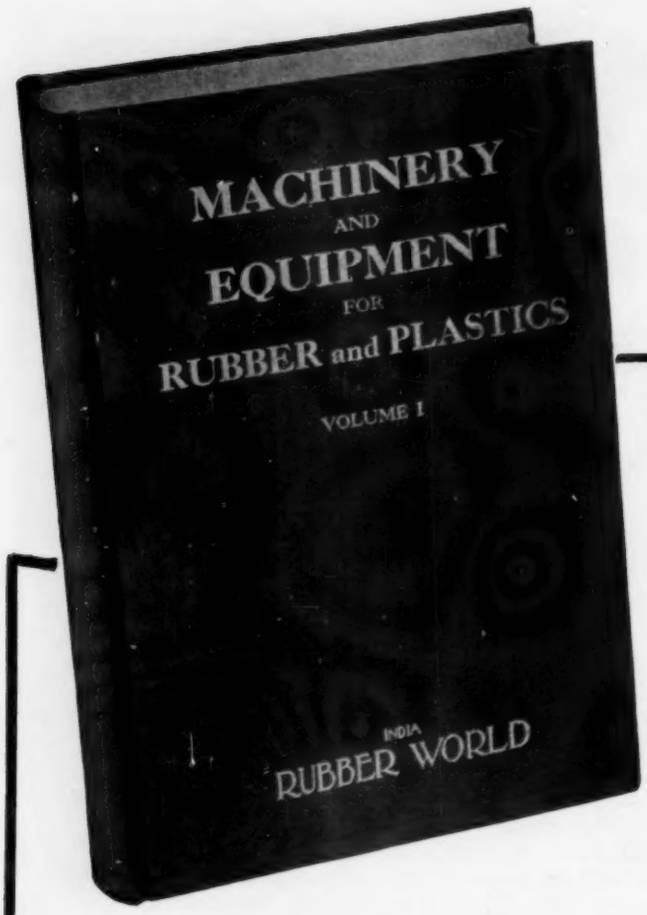

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PLASTICS TECHNOLOGY

JUNE, 1955

EDITORIAL: Manpower Education for the Plastics Industry

Even a casual survey of the technical manpower in the plastics industry reveals an interesting fact. While the materials supplier companies have a preponderance of chemists and chemical engineers in their laboratories and sales forces, this condition of educational selectivity of technical manpower ceases to exist as we move out into the molding and fabricating side of the business. Here, training varies considerably and we find all types of technical degrees among the personnel. In fact, there are many with non-technical degrees as well as others without formal degrees who are engaged in plastics fabricating. To sum up, it would seem that plastics engineers are made by experience in their work rather than by formal education.

•

What of the future? Is the industry to continue recruiting its personnel in this rather haphazard manner, or will it attempt to fill its personnel needs by means of a planned program? It is obvious that the latter course is much to be preferred and that education is the answer.

This educational approach should be two-pronged in nature. On the one hand, the program should include training at the college level. Plastics should be included in the curricula of all colleges and universities. This is taking place now, and more and more schools are either giving complete courses in plastics or are including plastics as a subject in related courses of study.

Unfortunately, however, most of these courses are theoretical or fundamental, and neglect practical applications. The student receives an education in plastics theory, but has no opportunity to translate this knowledge into actual molding practice. What is needed in this formal training is more emphasis on plastics practice in addition to theory.

Secondly, there must be "in-industry" training. These should be programs by the industry rather than by one company, and be designed to up-grade the knowledge of younger and newer personnel. A start has been made in this direction by the rubber industry, where some local groups are giving courses taught by industrial people and emphasizing practical knowledge. This approach is needed in the plastics industry where the national or local societies could undertake to give such courses.

•

The proposed program then would consist of two approaches, each complementing and supplementing the other. It would consist of college training in plastics, followed by industrial training. With such a program, the plastics industry could be assured of a continuing supply of technical personnel whose training is suited to the industry and its requirements.

Arthur M. Merrill

Editor

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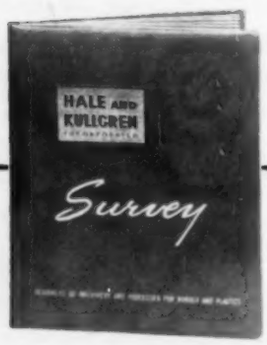

Program for Profits

Effects of Thermocouple Location and Wattage Control on Injection Cylinder Temperature

Inadequate temperature control because of improper thermocouple location and excessive heater wattage can seriously affect molding quality and cycle time.

A. R. MORSE, *President*
Injection Molders Supply Co., Cleveland, O.

At the present time, almost nothing is known regarding actual internal temperatures of injection machine heating cylinders. All temperatures conventionally used in adjusting injection molding heats are purely relative. Much speculation and widely varying opinions exist as to actual temperatures found inside heaters, and how and when they affect the melting of the plastic material passing through the cylinder. At present, temperature readings are taken from thermocouples that vary in locations up to as much as 250% between various types of cylinders. These variations, of course, relate to thermocouple hole depths, relative longitudinal location, and various ranges of wattages so controlled from these points.

In view of the marked increase in wattages being used today, it was considered important to determine just what temperatures are actually being obtained over wide areas of the internal surface of the heating cylinder, which is in direct contact with the plastic material. This is especially important when one considers that a cylinder length of up to 24 inches or longer may be regulated by the one small point in the cylinder wall against which the thermocouple tip impinges.

Our test results demonstrated quite clearly that a large majority of the heating bands considered as "controlled" are actually running rampant when their effects are measured from inside the cylinders. The cumulative effect of these vast excess wattages now being poured into critical molding powders without real regulation is undoubtedly a major cause of embrittlement, fish scales, bubbles, streaks, welds, "burning," and other visual causes of rejects. These rampant wattages also cause deterioration we cannot see, such as crazing around the gate, brittleness and greatly impaired usefulness in thermoplastic products because of warping, peeling, strains, undue darkening with age, failure to withstand low temperatures (in food containers), etc.

A. Reynolds Morse was born in Denver, Colo., and received a bachelor's degree from the University of Colorado in 1938, and a master's degree in production engineering from the Harvard Business School in 1939. He was in glass machinery producton with Hartford-Empire Co. from 1939-1940; was a sales engineer in the Cleveland office of Reed-Prentice Corp. from 1940-1949; and has held his present position since 1949. Mr. Morse is active in SPE and SPI, and founded the SPE Cleveland-Akron Section in 1944. He is the author of numerous articles on injection molding.

With present, much too limited instrumentation, we have no effective means of relating our indicated heats to actual material temperatures, especially at points too far distant from the thermocouple for it to regulate. Yet, today, huge wattages are definitely necessary for high speed quality molding. Two approaches are possible:

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Fig. 1. IMS Watson-Stillman type 8-12 ounce replacement cylinder used in tests. Locations of thermocouple holes are shown.

(1) improved instrumentation and the use of more and better located control points, as discussed here; and (2) improved heating cylinder design to provide a much greater internal area, so that lower actual cylinder heats can be used.

The present investigation was undertaken jointly by IMS and Wheelco to determine the variables being introduced into the injection process by various thermocouple locations, and also to evaluate the efficiency of various temperature controls. As such, the test results will directly benefit any injection molder who can readily adapt our suggestions to his present equipment for greater efficiency in handling the newer thermoplastics.

In setting up test conditions, IMS engineers also were interested in (1) determining why identical cylinders used with various types of injection machine mountings gave such a wide range of readings from apparently identical thermocouple locations; (2) determining what, if any, time lag occurred between the instant the thermocouple called for heat and the moment that this heat actually reached the plastic material inside the cylinder; and (3) determining what depth of thermocouple hole gives minimum variation in these actual internal cylinder wall temperatures.

Wheelco engineers were able to evaluate advance designs of instruments, and to conclude, if we may anticipate, that present techniques of instrumentation, when properly applied, give accuracy of control that will be almost impossible to improve further. Considerable educational work, however, remains to be done among molders so that they will get optimum results even with present controllers, let alone with still more refined units. An active program is being undertaken by both companies to help the molder utilize his present equipment more efficiently, and achieve better control of present cylinders with revised and added instrumentation where necessary.

Test Conditions

All tests were performed under static conditions; that is, the cylinders were empty, no cold material was being admitted, and nothing was being removed from the cylinder. Our conclusions from the tests, however, are weighted to compensate for these static conditions. Cylinders intended for Reed-Prentice and Watson-Stillman machines were utilized in the tests. The cylinders were approximately 30 inches long and 8 inches in diameter, with uniform wall sections approximately 1½ inch thick. The Watson-Stillman type test cylinder, shown in Figure 1, had a special air-gap insulation ring used to adapt standard IMS heaters for this type of injection machine to help minimize heat loss through the wedge block type of mounting.

Chromalox heater bands rated at only 1,250 watts each were used in the tests. It should be noted that, as a result of observations made during the tests, 1,400-watt heaters are now being supplied by IMS, especially for rear heater bands. Wheelco 2920 Capacitrols, with 0-800° F. range; dual A1133 thermocouples with compression fittings; a flexible 20-gage 1C thermocouple; and a 7000 Capacilog recorder with 0-800° F. range were used in the tests. Conventional contactors and switches were installed in the usual fashion.

At least four thermocouple positions were used in each test. The longitudinal positions were determined by counting the heater bands between the thermocouple well and the rear flange of the heater. By this method, one, two, three, or four bands were located between the thermocouple and the rear of the cylinder. The locations of these thermocouple holes are clearly shown in Figure 1.

Thermocouple depth positions were of two types: (1) within ¼ inch of the heater band; and (2) within ½ inch of the inside surface. Intermediate depths were also evaluated for comparative responses, and to double-check our conclusions. Internal readings were taken by means of a probing thermocouple which could be moved from one position to another, as desired. Due allowance of about 10° F. was made for variations attributed to contact errors of the probe.

Test Results

A summary of the tests and the conclusions reached is given in the following section.

Thermocouple Location

LONGITUDINAL. The tests demonstrated that the longitudinal location of a thermocouple should always permit installation of enough heater bands to compensate for varying degrees of heat loss through the different types of mountings. If the thermocouple is less than three bands from the rear of the cylinder, consistently low readings may be obtained at the rear control point. Evidence of serious overheating then can sometimes be found towards the front of the rear zone of control.

In actual practice, it was proved that on shots which are far below the calculated capacity of the tunnel, alternate flashing and short shots may result from having the thermocouple too close to the rear mounting, or not deeply enough embedded in the cylinder wall. Merely lowering the heat settings on under-capacity work did not correct this condition, and it was necessary to reduce the wattage by disconnecting the center bands on the cylinder until the requirements of the under-capacity job were in proper proportion to the increased efficiency of the over-capacity cylinder. Conversely, in many cases with large shots it was found that the rear thermocouple never came up to heat, and the rear control never shut off when the couple was too close to the rear of the tunnel. We believe, therefore, that many rear thermocouple locations should be re-evaluated as to shot size and heater capacity, and the

thermocouples moved forward from one to two bands to prevent overheating at the front of the rear control zone on small shots, and to eliminate heat lag on large shots, especially with longer heaters.

We found no evidence of possible overheating of the plastic in the rear six inches of length of the cylinders tested, since the cylinder wall radiates excess heat to the mounting and, of course, to the incoming material under actual molding conditions. Figure 2 illustrates the abrupt downward curve in actual cylinder temperatures towards the rear of the cylinder. Conversely, there is a steady increase observed in available heat as we go farther into the cylinder. Unfortunately, we cannot get enough heat into the rear of the conventional cylinder to achieve the more desirable reverse curve where the cylinder wall would be hottest at the rear, and then become comparatively cooler while the plastic itself becomes hotter as it travels forward.

A second and highly recommended alternative method of preventing overheating in the central portions of new, longer, high-wattage cylinders is to install additional pyrometer controllers to regulate the front groups of heater bands which are located farther away from the rear control point. This conclusion is based on our observation that effective control from one thermocouple hole does not extend longitudinally much farther than the area covered by two 1½-inch wide Chromalox bands, or a total length of six inches when cylinder conditions are uniform and not affected by bleed-out of heat into the mounting blocks.

In other words, serious overheating of thermoplastic materials probably occurs today in every case where the thermocouple is asked to control temperatures beyond its effective reach, especially in the front and center portions of the average cylinder. In such cases, the first two or three bands forward of the rear couple normally would be "on" all the time to compensate for incoming cold material and bleed-out. Therefore, fully effective control, in terms of actual cylinder inside wall temperatures, cannot possibly be achieved with the bands located more than 3-4 inches forward of the rear thermocouple hole.

Proceeding forward from the area under actual control of any couple, the temperature rises steadily until an area is reached where abrupt overheating can occur simply because it is too remote from the control point. The rear controlling couple, in particular, must be located far enough forward so that it will overcome and not be affected by bleed-off and heat loss to the cold incoming material and to the mounting. In addition, the rear couple should not be loaded with a large number of bands beyond its forward reach of control.

To meet modern conditions, we conclude that either (1) each heater band should have its own individual Variac control, with the thermocouples used only for indication purposes, or (2) enough additional control points should be used to prevent the overheating described above. The latter method is probably the more economical course of action at the present time.

HOLE DEPTH. Considerable controversy exists over the depth of thermocouple holes in injection machine heating cylinders. Some persons advocate placing the thermocouple just under the heater band. Others recommend as deep a thermocouple hole as can be drilled safely so as to be as close as possible to the actual material temperature. Shallow thermocouple holes do not take account of heat flow, and would be suitable if band temperature were more critical than the plastic material temperature. Such is not the case any longer with the new oversize tunnels.

Measurements taken during our tests seem to indicate that the deeper the thermocouple hole, the less actual fluctuation found in temperatures measured on the inside of the cylinder. The pyrometer did not flick off and on as frequently as with shallow thermocouple holes. Even though the off-on cycles of the controller were much longer, the soaking effect and distribution of the heat as it penetrated the steel gave less actual fluctuation of the internal wall surface temperatures than was obtained with shallow thermocouple hole locations and more rapid cycling of the controls.

Certain marked differences in temperature readings taken during duplicate tests were noted. These variations were traced finally to poor physical contact of the thermocouple tip. We concluded that more attention should probably be paid to thermocouple mountings. Under production conditions, these recorded variations would be almost impossible to detect, and would be reflected by unexplained overheating and consequent degrading of the molding material.

Use of Silicone grease in the thermocouple holes gave much more consistent readings, and is to be recommended together with careful inspection of the thermocouple tip, contact, fittings, etc. Wiring connections should also be clean and free from grease, and have positive crimped connectors to avoid unsuspected temperature errors caused by poor thermocouple lead wire contacts.

Wiring the Cylinder

Our tests indicated an unaccountable and wholly unexpected variation between temperature readings taken at the 4, 8 and 12 o'clock positions around the cylinder circumference. Some of this variation was due to convection and the tendency of heat to rise, and some of it was traced to the location of the gap between heater

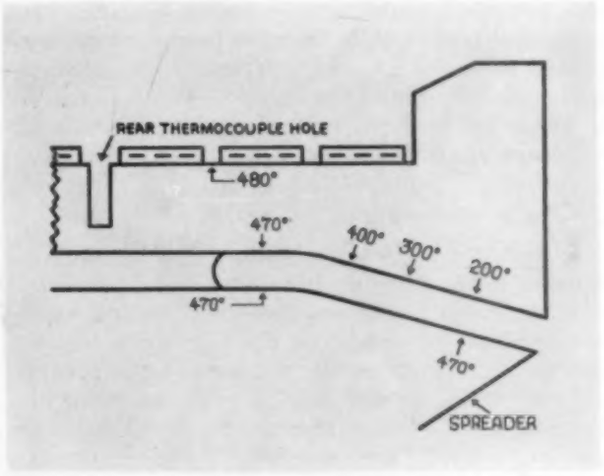

Fig. 2. Schematic illustration of decline in actual cylinder temperatures towards the rear of the cylinder, as shown by test results.

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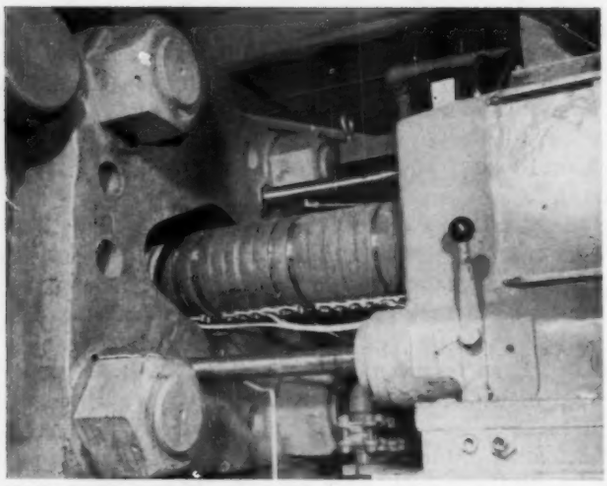

Fig. 3. Cylinder wired with gaps of heater bands in line at bottom of cylinder.

bands and the position of this gap on the outside of the cylinder.

When the cylinders were wired so that the heater band gaps were all in line at the bottom of the cylinder, as shown in Figure 3, measurements indicated a variation of internal surface heat ranging from 488° F. at 12 o'clock, to 470° F. at 4 o'clock, and 475° F. at 8 o'clock after a one-hour soaking period. When the cylinder was rewired, as shown in Figure 4, with each band alternately reversed, the temperature variation was reduced considerably, but could not be completely eliminated. It was also noted that the farther forward the probe was placed in the cylinder, the less this temperature variation, regardless of how the bands were wired.

On longer cylinders, our tests clearly prove that each band should be staggered by reversing it so that the terminals are in line, but the gaps are not. Also, we would recommend that the gaps be positioned toward the upper part of the cylinder, rather than the lower, so as to compensate for the unexpected hot zone observed at 12 o'clock on the cylinders regardless of how or where the gaps were positioned. Thus, even with full circle heating, a hot zone seems to run down the top of the cylinder at 12 o'clock. On critical material, this effect could cause streaking, degrading, fish scales, and bubbles if the injection machine is operated beyond its actual safe molding capacity, or where the melting-molding-decomposition range of the material is within 10° F., as is increasingly common with the new heat-resistant copolymers.

Jetting in the Cylinder

Recent studies by Dow Chemical Co. uncovered clear-cut proof of the marked effect of spreader design on thermoplastic melting. The Dow researchers recorded an unexplained jetting effect through the heater, and were able to determine the actual location of the spreader webs by measuring temperature variations. Their purging and other tests clearly proved that some anomaly exists in the spreader region of the modern cylinder.

Our own tests of heat being transferred through the spreader webs help account for this phenomenon. As shown in Figure 5, we proved that the heat of the webs is 10-15° F. higher than the heat at the top and bottom of the holes, as long as heat is being drawn into the spreader. Therefore, with a tunnel in operation, this phenomenon of more heat being found on spreader webs or legs than elsewhere clearly accounts for the jetting action recorded by Dow technicians, and the failure of some heaters to purge out and to perform as well as others.

The results of the Dow observations, as well as our own studies, clearly prove the need for larger internal heater areas, larger and more uniformly distributed wattages, and better temperature control in order to mold thermoplastics faster and better. The studies also seem to indicate the futility of many experimental heater designs that we, as well as others, thought held some promise of heater improvement. In actual practice, IMS experimental cylinders with loose or floating spreaders, cruciform shapes, and channels or other unusual hole patterns have conformed to the Dow findings that there is one general design pattern that exceeds all others in utility and efficiency. It was on heaters of this generally optimum design that all temperature recordings discussed here were taken.

In summation, the typical injection cylinder seems to require use of more controllers to avoid overheating in the forward position where more than two bands are controlled ahead of the rear control point. Deeper thermocouple holes appear to give less variation of internal cylinder wall temperatures than do shallow holes. Finally, the staggering of heater band gaps is suggested to overcome unexpected radial temperature variation observed on inside cylinder walls. This variation has been traced partly to the unheated gap found on any type of band, and partly to the tendency of the top of the heater to run hotter than the bottom, regardless of the type of band used.

Field Tests of High Wattage Cylinders

Subsequent to the laboratory tests described above, three oversized cylinders were compared in the field with a view to determining what occurs when a greatly increased wattage is spread over a larger heating area. Each of the three cylinders tested had a carefully calculated decrease in watt density, as follows:

Cylinder #1 was a standard IMS 14-ounce unit adapted for use on the Reed 8 machine. This cylinder had a wattage of about 11,000, and a watt density of

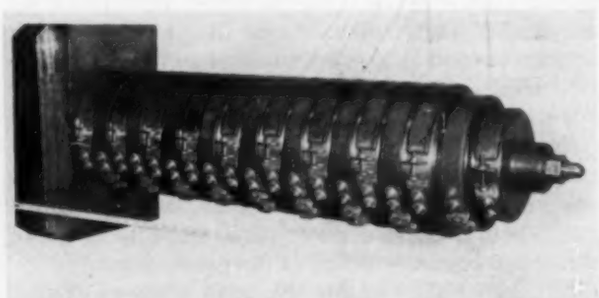

Fig. 4. Cylinder wired so that heater band terminals are in line, but gaps are staggered. For best results, gaps should be at the top of the cylinder.

approximately 34 watts for each square inch of surface area.

Cylinder #2 was also eight inches in diameter but much longer (requiring alteration of the machine to accept it). This unit had a wattage of about 17,000 and a watt density of 32 watts per square inch. This cylinder is shown in Figure 6.

Cylinder #3 was 10½ inches in diameter, and also had a wattage of around 17,000 watts. This cylinder (shown in Figure 7) did not require alteration of the press, even though it has more heating area than the longer unit, or about 30 watts per square inch in the critical melting area.

As the effective watt density was decreased through the use of larger internal heating areas, we recorded a definite drop in molding temperatures. Cylinder #1 ran at 550° F.; the extra-length cylinder #2 at 500° F., and the over-diameter unit (#3) at 450° F. These various heats all produced material that gave a ribbon or wire probe reading of 430° F. on a 30-second cycle, indicating that more heat was being introduced with the higher wattages even at their lower heat settings. This effect is also shown in Table 1, which compares an original equipment cylinder with two IMS tunnels; one a stock model replacement unit, and the other a new high-wattage unit for the same press.

Table 1. Comparative Heating Performance of Injection Cylinders

	Wattage	Melting Area, Sq. In.	Pyrometer Setting, °F.	Material Temperature, °F.	Cycle Time, Sec.
Std. Reed	9,500	22	675	430	30
IMS 14-oz	11,000	29	550	430	30
IMS Jumbo	16,900	34	500	430	30

On a copolymer that was demonstratively heat-sensitive, production records proved that better results are obtained with higher watt densities spread over larger areas. Higher wattages, alone, did not produce results comparable to those obtained where the exposed surface area was also increased commensurately. This indicates that many standard cylinders today are being severely overheated.

The only way that comparable results from an 11,000-watt heater could be obtained was to lengthen the molding cycle to permit use of comparably lower heats. In other words, to produce a material that gave a ribbon or probe reading of 430° F. with a cylinder heat of 575° F., the cycle had to be lengthened to 50 seconds (instead of 30) to give the tunnel enough time to add the full measure of heat to the plastic. With the standard cylinder at heating settings of 650° F. and a faster cycle, degrading occurred and the product was rejected for discoloration, bubbles, and mica effects.

The inescapable conclusion of these tests is that either longer cycles and lower heats must be used for certain copolymers, butyrate, and vinyls, or else oversize heaters must be supplied which are equipped with a sufficient number of controls (from 4-8) to keep each

(*Continued on page 294*)

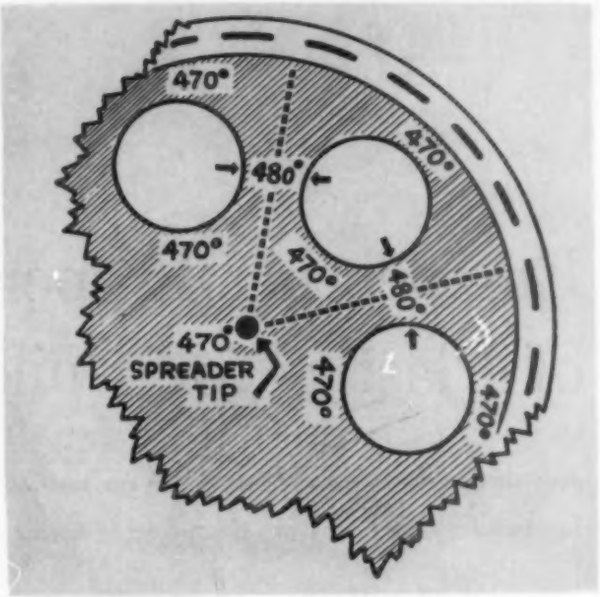

Fig. 5. Schematic drawing of spreader showing how temperature runs 10° F. higher in the webs than in the holes during heating-up operation.

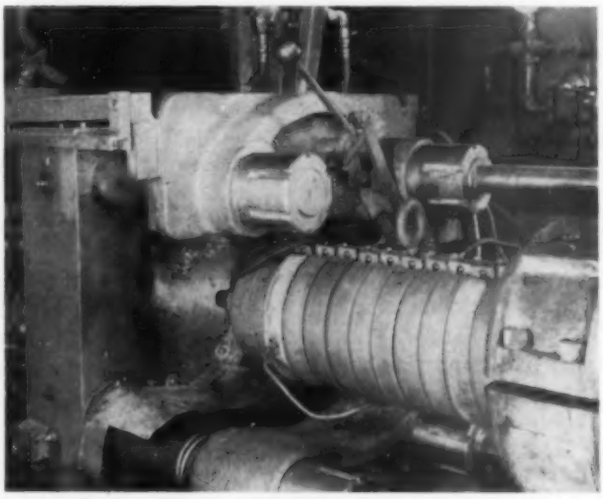

Fig. 6. IMS extra-length 17,000-watt cylinder adapted to a Reed 8 type machine.

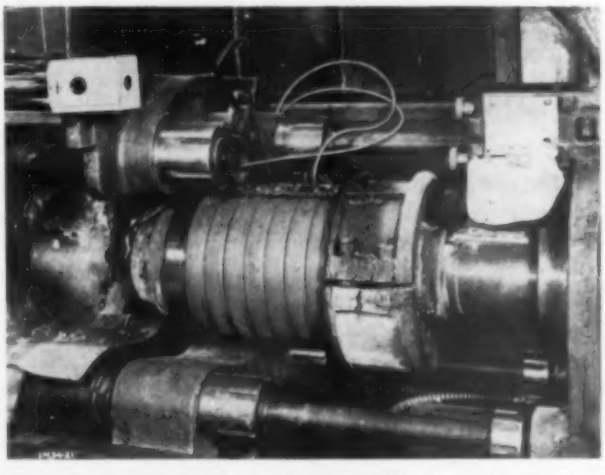

Fig. 7. IMS extra-diameter 17,000-watt cylinder adapted to a Reed 8 type machine.

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Engineering Properties of Plastics for Building*

Advantages and disadvantages in properties of plastics for building purposes are discussed in terms of current building trends.

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Plastics are already used in building in considerable quantities and there is lively interest on the part of plastics manufacturers and engineers, builders, and architects in the construction potentialities of plastics.

One of the oldest uses of plastics in buildings is as adhesives used in waterproof plywood and other glued constructions. Plastics made possible better varnishes, lacquers, drying oils, and other finishes today widely used in buildings. Plastics combined with wood, paper, and fabrics provide building boards of superior qualities. Large quantities of plastics are used in flooring. Upholstery and wall coverings are made of tough sheets, coated fabrics, and woven plastics.

Transparent and translucent plastics are used in such places as schoolhouse windows and street lights where breakage and maintenance costs are high. They are used for skylights and illumination where their ready formability makes them especially adaptable. All of these applications came about because of certain physical properties and combinations of properties to be found in plastics.

Physical Properties

The range of properties of plastics, including laminates within their own limits is as great as the range of properties of metals, and is much greater than that of either concrete or timber. This is brought out in Figure 1, in which the tensile strength ranges of the principal classes of plastics, and of plastics-based laminates and reinforced plastics, are compared with iron and steel alloys, aluminum alloys, copper alloys, wood, and concrete. Depending upon the formulations and reinforcing materials employed, plastics may be extremely weak or extremely strong with a range approximately 200:1.

Elastic and Plastic Behavior

To some degree plastics behave in an elastic manner; that is, deformation under load is directly proportional to the load, and deformation disappears when the load is removed. In engineering design, steel, concrete, and timber are assumed to behave elastically. Some plastics, especially the thermosets, are also essentially elastic within appropriate stress limits.

Plastics behavior, in contrast to elastic, involves the flow or creep of materials under load, so that the deformation depends not only on the load but also on the loading rate and duration. When the load is removed the material may eventually recover all or part of the deformation. Concrete and timber are plastic to some degree, and deformation, especially under high stress, is likely to increase with time. The same is true of metals at high stresses and at elevated temperatures.

Many plastics, especially the thermoplastics, exhibit time-dependent plastic behavior. The effect is greater at elevated temperatures, and may be quite marked at temperatures found in buildings (as with hot water lines, roofs and walls exposed to the sun, and similar elevated-temperature conditions). These materials become stiffer and stronger as the temperature drops and, eventually, most become brittle at temperatures of 0° F. or below.

Their strength, and the amount of deformation before failure occurs also depend on the rate at which these plastics are loaded. If loaded quickly, they carry higher loads, but stretch or otherwise deform less before failure than when loaded slowly. The effects of temperature and rate on the load-deformation behavior of such materials are shown diagrammatically in the stress-strain curves of Figure 2.

* Based on a paper presented at the "Plastics in Building" Conference, Washington, D. C., Oct. 27, 1954.

Materials which exhibit plastic behavior are subject to creep. When loads are imposed, these materials tend to continue to deform as time passes, and the degree of creep depends on the range of stresses and temperatures encountered. If stresses are low enough and temperatures are moderate, creep is small and may be of no particular importance.

This is illustrated in the lowest curve of Figure 3 which shows a typical low-stress creep curve at moderate temperatures in which creep eventually dies off to zero. This curve also shows that if the load is removed (dotted line), the material eventually returns to its original undeformed condition. The second curve shows a condition of higher stress in which creep continues to increase slowly with time. If continued long enough this may lead to failure. If unloaded (dotted line), most of the deformation is recovered, but some residual deformation remains.

As stresses or temperatures increase, creep also increases and may lead to rapid distortion and failure as in the upper curve of Figure 3. Plastic pipe, for example, which might be entirely satisfactory for cold water at normal pressures, could well be completely unsatisfactory as a hot-water line.

Although engineers, builders and architects are familiar with the fact that the strengths of materials are dependent upon temperature, stress, and duration of load, these factors are of relatively minor significance for many construction materials. In the case of many plastics, particularly thermoplastics, this relationship is of major significance and must be taken into account.

If it is, the plastics can be employed satisfactorily; if it is not, failures may occur. Appropriate stress levels and factors of safety must, therefore, be employed. For materials exhibiting no sharply defined yield points or elastic limits, the working stresses are more dependent upon the degree of creep which can be tolerated than upon yield points or breaking stresses.

Fillers and Plasticizers

Plastics are greatly modified in their properties by the judicious addition of fillers and plasticizers. Fillers are used primarily with thermosetting materials, and plasticizers primarily with certain thermoplastics.

The same basic thermosetting resin may be given a wide range of properties depending upon the type and quantity of filler added. This is shown in Figure 1 by the ranges in strength properties for the phenolic, urea, and melamine resins.

Plasticizers are commonly used with thermoplastics, some of which, in their unmodified state, are too brittle and too hard to be molded at temperatures below their decomposition points. Others, although moldable, may be too hard and brittle for their intended uses. Plasticizers have much the same effect at ordinary temperatures as heat has in increasing plasticity, flexibility, and, frequently toughness. Strength is generally decreased at the same time.

By varying the plasticizer content, the same plastic can be varied from hard, rigid, and brittle to soft, distensible, and tough. The cellulosics and polyvinyl chloride are particularly good examples of the use of plasticizers to provide a wide range of hardness, strength,

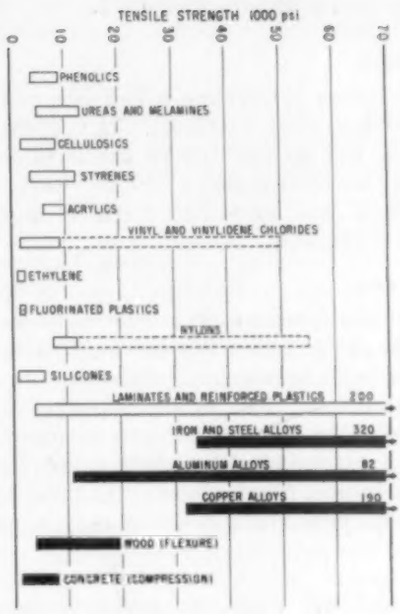

Fig. 1. Tensile strength ranges for plastics and conventional building materials.

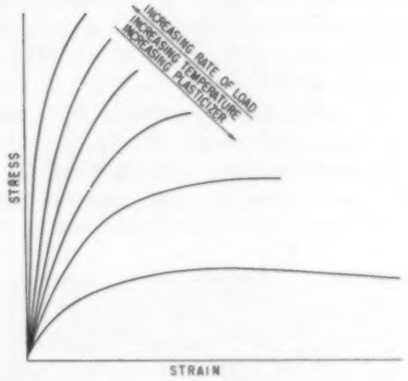

Fig. 2. Effects of loading rate, temperature, and plasticizer content on stress-strain behavior of plastics.

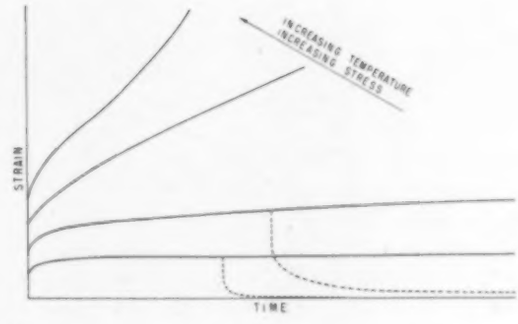

Fig. 3. Effects of temperature and stress on creep properties of plastics.

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and flexibility, as shown in Figure 1.

Orientation

When certain plastics are drawn into fine filaments, their strength rises markedly. This phenomenon is utilized in the manufacture of textile materials. It is interesting to see in Figure 1 how the vinyls and nylon, for example, are increased in tensile strength when drawn into filaments.

Copolymers

Several basic plastic types may be built into the same molecular chain. When this occurs, a wide range of properties may be obtained, depending on the types and proportions of basic plastics employed. Many such copolymers exist. The range of properties shown in Figure 1 for styrene and the acrylics stems largely from copolymerization. The cellulosics and vinyls similarly can be copolymerized in addition to being plasticized.

Stiffness

Compared with traditional structural materials, the stiffness of plastics, as measured by modulus of elasticity, is generally low. As shown in Figure 4, the thermosetting materials are in the same general range as wood and concrete, but the rest of the plastics, other than the laminates and reinforced plastics, rank lower than all of the traditional structural materials. All of the plastics rank well below all of the metallic alloys. Magnesium, not shown because it is not customarily found in buildings, ranks slightly higher than the upper limits of the plastics.

For most construction materials, the modulus of elasticity is simply defined as the ratio of stress to strain at some specified portion or point of the stress-strain curve. Variations from this value are not great under ordinary conditions. The same holds true of those plastics which exhibit little or no creep. If creep occurs, however, strain is no longer directly proportional to stress, and the plastics part sags or otherwise distorts under load with time. In effect, the stiffness, or modulus of elasticity, decreases.

The modulus of elasticity, therefore, varies with time and ought, perhaps, to be called a modulus of plasticity. By using correspondingly reduced moduli, plastics parts can be designed for long-time loading and long-time allowable deflections.

Laminates and Reinforced Plastics

Where large sheets, large molded objects, or high strength are required, the answer is usually found in laminates and reinforced plastics. In these materials, plastics have been combined with sheet or fibrous materials to produce a composite which has properties unavailable in either constituent alone.

The term "laminate" usually refers to a sheet material which has been made under high pressure and high temperature, and the term "high-pressure laminate" is often used to differentiate this class of materials from reinforced plastics, formerly called "low-pressure laminates." Paper, fabric, wood and other sheet materials are combined with thermosetting resins, usually phenolic, melamine, or both.

The building field uses large quantities of these materials for table tops, counter fronts, furniture, wall coverings, and other applications where their strength, toughness, resistance to marring, and resistance to water, alcohol, and other commonly found solvents, make them particularly useful because maintenance costs are low, and refinishing costs are largely eliminated.

Reinforced plastics refer to plastics employing fibrous reinforcements, almost always some form of glass fiber, combined with a liquid resin which is converted to a solid by catalysts and hardeners, with or without heat

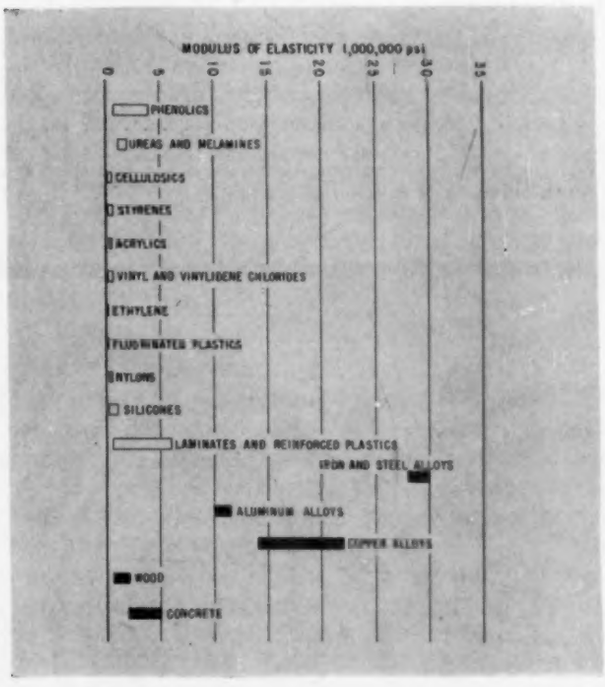

Fig. 4. Modulus of elasticity (stiffness) ranges for plastics and conventional building materials.

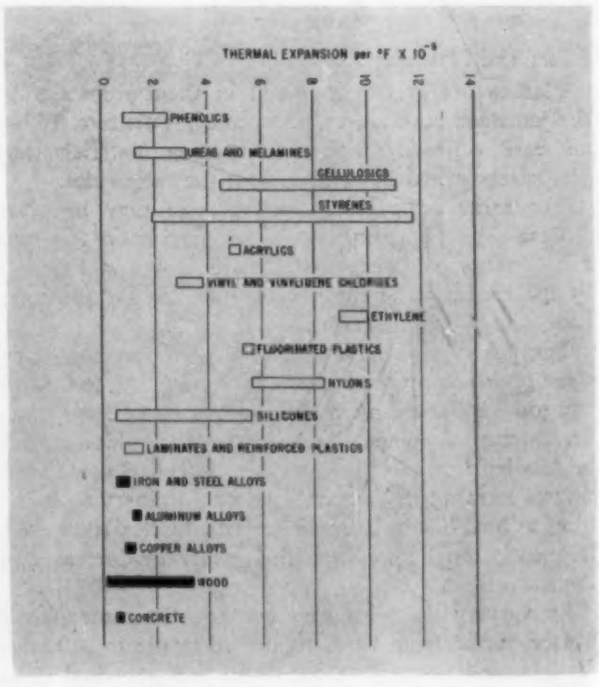

Fig. 5. Thermal expansion ranges for plastics and other building materials.

or moderate pressure. Because the heat and pressure requirements are moderate, it is possible to make large compound-curved parts on relatively simple molds as contrasted with the tool steel molds and heavy presses required for ordinary molding and for high-pressure laminates. Familiar examples of reinforced plastics are auto bodies, the corrugated sheet beginning to be used in large quantities in buildings, boat hulls, and a large variety of other similar applications.

The engineering design of laminates and reinforced plastics introduces some interesting and complex problems faintly similar to the problems of reinforced concrete design. In the design of metal structures and of plain concrete, the materials are assumed to be homogeneous and have the same properties in all directions.

When plastics are combined with fabrics, especially unidirectional fabrics, the strength properties are strongly influenced by the directional properties of the fabrics. Accordingly, such familiar constants as the modulus of elasticity and Poisson's ratio become variables dependent on fabric direction. Strength, of course, is also greatly influenced by direction. Surprising and complex interrelationships of stress occur within and between the layers of the laminate, so the engineering designer must be wary and alert.

The extremes of strength properties shown in Figures 1 and 4 are reflections of these directional effects. At the low ends, the properties are largely those of the resins alone; at the high ends are found rods containing a very high proportion of glass filaments all carefully aligned in one direction.

The variety of reinforcing materials available, and the freedom with which these may be arranged to meet the loads imposed, gives the engineering designer wide latitude in tailoring his materials to meet the requirements. Furthermore, engineering and architectural designers have practically unlimited freedom in selecting shapes, forms, and other structural elements.

Sandwich Constructions

In sandwich constructions, two thin, hard, strong facings are combined with a relatively thick, lightweight, weak core to provide combined lightness, strength, and rigidity. The facings provide the strong elements, but would buckle under bending and compressive stresses unless supported laterally by the core, which must be stiff enough to provide this support. The core must also resist the shear stresses occurring in the sandwich as it bends. The adhesive bond between facings and core must resist shear and tensile stresses between these components.

Many combinations of materials can be employed in sandwiches. The building industry already uses sandwiches composed of insulating board cores and cement-asbestos facings, metal facings and lightweight concrete cores, and various others. Plastics enter into this picture to provide structural and decorative facings of high-pressure laminates or reinforced plastics; cores of foamed plastics or of honeycombs; and the high-strength engineering adhesives to bond all sorts of facings and cores together.

Thermal Expansion

In building design it is frequently necessary to take into account the thermal expansion and contraction of materials, whether metal, concrete, wood, or plastics. The thermal coefficients of expansion of plastics are higher than those of metals, as shown in Figure 5. In the design of plastics parts, especially if they are to be used in conjunction with other materials, this feature must be kept in mind. It is not insurmountable, but is something to allow for in design.

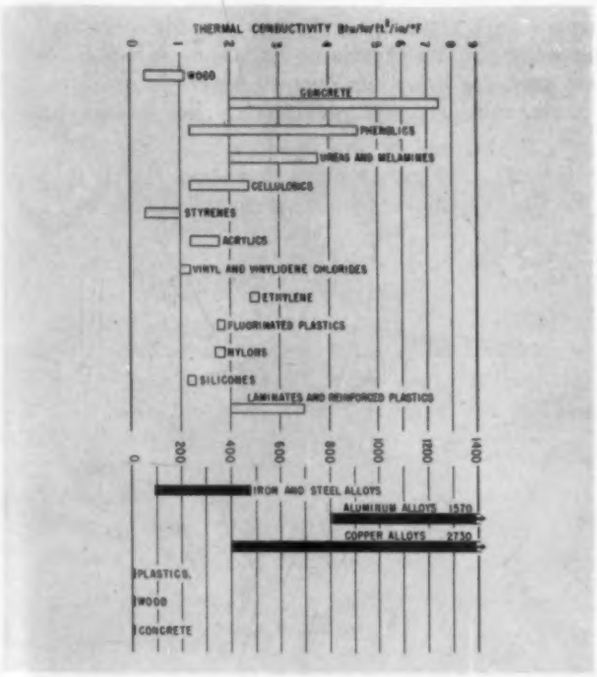

Fig. 6. Thermal conductivity ranges for plastics and other building materials.

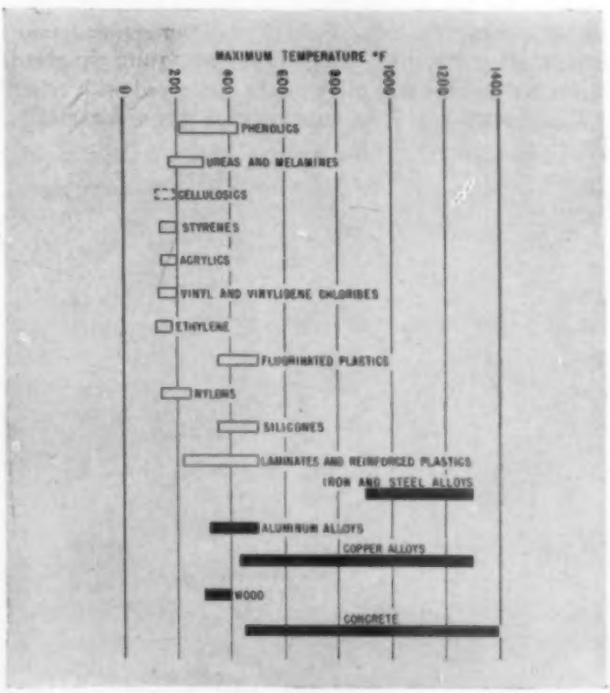

Fig. 7. Approximate maximum service temperature ranges for plastics and conventional building materials.

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Thermal Conductivity

Like most other nonmetallic materials, the thermal conductivity of plastics is low, although it varies from plastic to plastic, as shown in Figure 6. Few of the plastics approach the heat insulating value of wood perpendicular to the grain (lowest value of wood), but all are vastly better insulators than any of the metals.

Durability

CORROSION. Resistance to corrosion and to attack by a wide variety of solvents is one of the most attractive features of many plastics. At least one plastic material can be found to resist practically any corrosive condition encountered in building. The fluorinated plastics are particularly outstanding, and are used in the highly corrosive chemical industries. Polyethylene is highly resistant to attack by a wide variety of corrosive materials at temperatures below its softening point. The silicones are inert and, like the fluorinated plastics, highly moisture-repellent.

Moisture absorption by other plastics varies from practically zero to moderate. Other plastics are selectively attacked by classes of solvents, so that the choice for any given condition should take this selectivity into account. For corrosive conditions normally encountered in buildings, the plastics as a whole are excellent.

HEAT. All plastics can be destroyed by fire. They may either burn easily or be self-extinguishing, depending on the basic resin and the fillers and plasticizers compounded with them. Building designers recognize that resistance to fire is to a large extent a matter of proper design as well as proper selection of materials. Buildings constructed of incombustible materials have been disastrous losses in fires, whereas other buildings of combustible materials have stood up well.

Maximum temperatures to which plastics should be exposed are not easy to establish because use conditions are extremely variable. Maximum recommended temperatures for more or less continuous exposure are given in Figure 7, in which plastics are compared with other building materials. The temperatures given for metals and concrete are the temperatures at which strength drops to approximately 50%.

The wood temperatures shown are based more on the chance that charring will occur than on loss of strength, because wood does not become weaker upon heating. Concrete temperatures are uncertain because, when concrete is used as fireproofing for steel, its insulating value rather than its strength is important. On the other hand, some lightweight concrete load-bearing structures may easily lose more than half their strength at fairly low temperatures.

Among the plastics the silicones and the fluorinated plastics are outstanding in temperature resistance. Laminates may be highly resistant if the basic resin is resistant, and the reinforcement an inorganic material like glass or asbestos. The thermoplastics are sensitive to heat, and the recommended temperatures are based upon creep and distortion rather than ignition. Manufacturers of cellulosics, because of the range of basic types and of plasticizer contents, hesitate to recommend specific maximum temperatures. Thermosetting plastics, as is to be expected, are generally superior to the thermoplastics.

Irradiation of some plastics has been shown to raise their heat distortion temperature markedly. Polyethylene bottles, for example, which collapse or distort badly at 150-175° F., retain their shape at temperatures between 300-400° F. after irradiation. A cross-linking action occurs binding the molecules together in a structure similar to thermosetting plastics, thereby raising their resistance to distortion by heat.

WEATHERING. Resistance to weathering over long periods of time is one of the most uncertain aspects of plastics. Whereas it is reasonably certain that indoor exposures have relatively little effect on most plastics, outdoor conditions may affect many of them adversely. Many of the large-volume plastics in use today were emerging from the laboratory 10-20 years ago, and changes in formulations are being made continually. For many plastics, therefore, there is no record of outdoor exposure extending over long periods of time.

A few transparent plastics, such as the acrylics, have

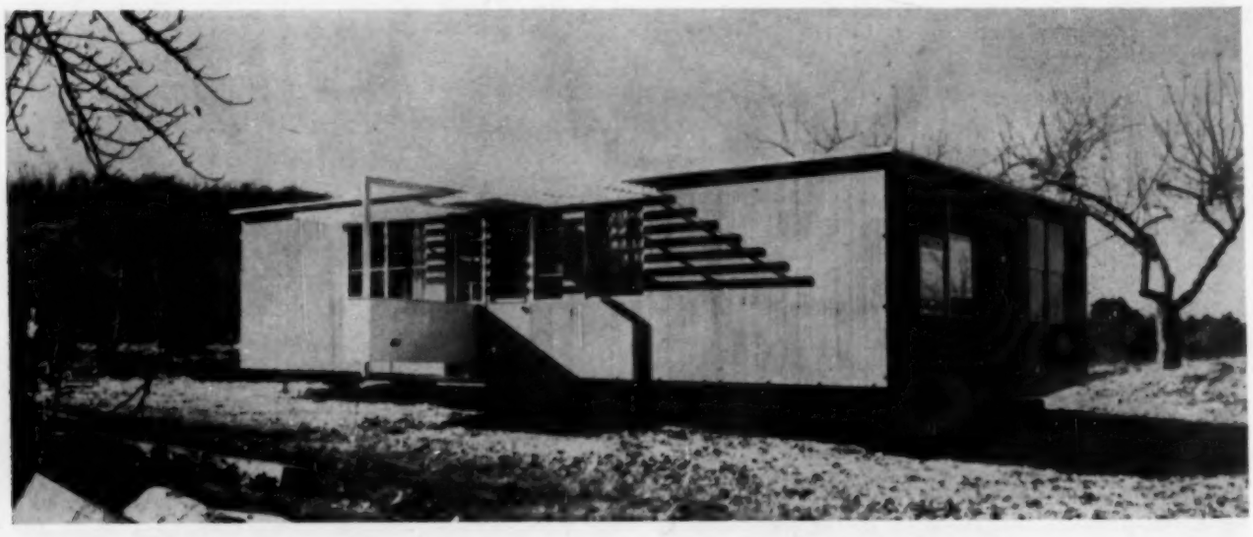

Fig. 8. Shop-fabricated house uses sandwich panels for walls, roof, and floor.

been used for aircraft glazing and other outdoor applications for periods ranging up to 20 years. Their performance, therefore, is relatively well known, and they can be expected to give a good account of themselves in buildings. The phenolics also have had a fairly long history of outdoor exposure. Loss of gloss and dulling of colors can be expected to occur upon weathering, but properly formulated phenolics have been satisfactory outdoors for periods ranging to twenty years or more.

Long histories are lacking for most other plastics, but the chemical natures of the fluorinated plastics and the silicones indicate that they should have outstanding long-time weather resistance. High cost stands in the way of large-scale use of these materials. Certain of the vinyl and vinylidene compounds, especially when formulated with carbon black and other ultraviolet light-excluding pigments, show promise on the basis of exposure histories ranging up to 10 years.

The lack of completely reliable accelerated weathering tests, which are difficult to set up because of the complexities and vagaries of actual weather, is a serious obstacle to the adoption of promising new plastics as they appear. In building, the customary units of time are 20-50 years, and designers hesitate to use materials which have not proven themselves in actual use. This attitude, while perhaps a deterrent to rapid progress, is understandable, and plastics manufacturers must recognize that it exists.

Building Trends

Several major trends in building design and construction are bound to have a decided influence upon the possible uses of plastics in building. Perhaps the most important is the trend toward shop-fabricated units assembled quickly in the field to reduce expensive field time and field labor. Large shop-fabricated building panels, particularly for walls but also for floors and roofs, are becoming common not only in dwelling houses but in industrial and commercial buildings.

The stressed-skin principle is already in use in housing, and the application of load-carrying sandwiches is beginning to grow. A major problem still calling for completely satisfactory solution, is the caulking and sealing of the joints between these panels. The highly durable, though expensive, plastics might help to solve this problem.

Mechanical and electrical equipment, and built-in features of all kinds are being shop-fabricated to a greater and greater extent to reduce field labor and erection time. Portability, including minimum weight and resistance to damage in transit, becomes important. The lightness and flexibility of design of plastics, coupled with good strength and impact resistance, can make them attractive for all of these applications.

Figure 8 shows a small, completely shop-built house with wall, floor, and roof panels of waterproof plywood facings bonded to a honeycomb core of resin-impregnated paper. The house can be folded, transported on a trailer, and erected on a grid of foundation beams in a matter of hours.

A second major trend is toward large clear spans to avoid internal supports. This provides freedom for industrial operations, and allows for easy rearrangement

Fig. 9. Domed skylight made of vacuum formed plastic sheet.

of office space. Even in dwellings there is a trend toward roof construction spanning the outside walls to eliminate bearing partitions and allow for free arrangement of space. Flat slabs, cantilever construction, and long spans are, consequently, becoming common in buildings.

There is also a trend toward highly efficient structural shapes such as shells, domes, arches, and vaults spanning very large spaces. Space frames also are efficient for the enclosing of large spaces. Here, it is entirely possible for plastics, although they may not be used for the primary load-bearing members such as arches, to be fitted into the structure in the form of secondary load and light-transmitting units. The readiness with which many plastics can be formed into complex shapes recommends them for these purposes in competition with other materials more difficult to shape.

The ready formability of materials like reinforced plastics recommends them for the making of complex forms for grid and cell constructions of reinforced concrete. Such forms have already been used for precast concrete slabs. This use could readily be extended, particularly where complex shapes and reuse of the forms are required.

A major problem exists, for example, in the forming of thin concrete large-span domes. A strong deterrent to greater use of these efficient structural shapes is the cost of forming. It is conceivable that segmental forms could be built and rotated about a central axis as the dome is cast, thereby reducing the amount of forming material required. Possibly plastics could provide the tough curved surfaces of such forms.

Figure 9 illustrates the ease with which some plastics can be formed into efficient structural shapes. The bubble-shaped skylight was vacuum formed and although a quarter-inch or less in thickness, is capable of withstanding several hundred pounds per square foot of pressure applied either to the inside or the outside.

A third major trend, coupled with open plans and minimum interior obstructions, is the greatly increased use of transparent and translucent walls to admit maxi-

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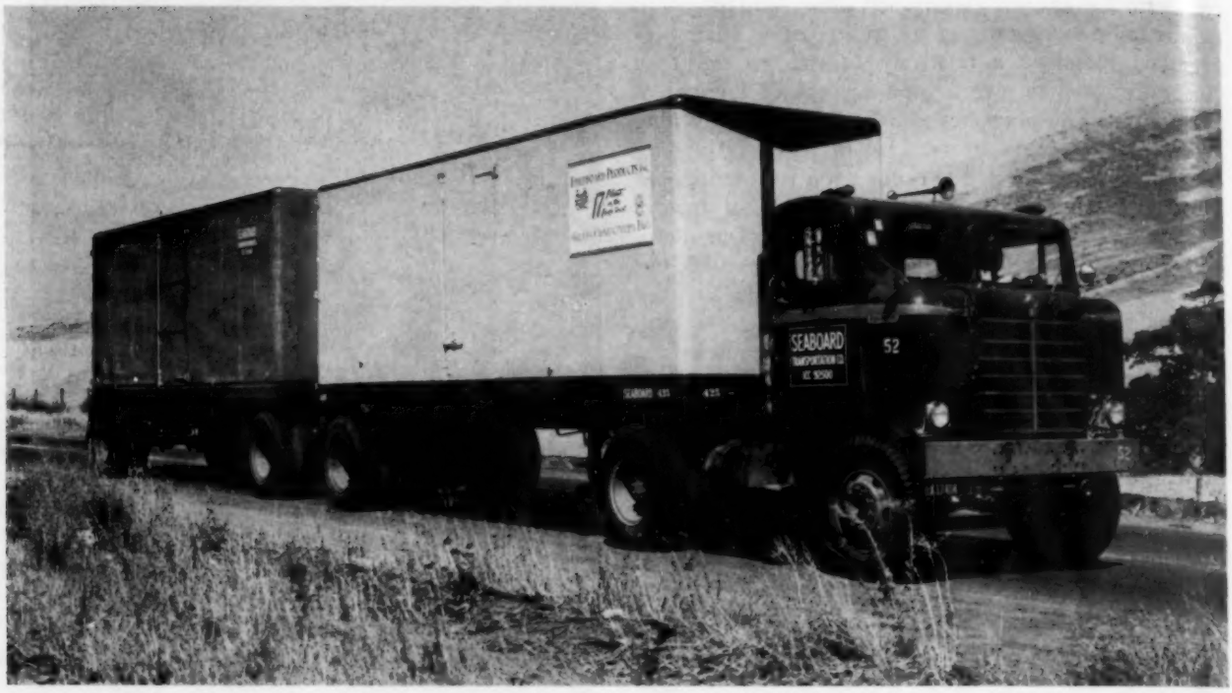

Fig. 5. Plastic van trailers in operation. Rear van is unpainted for test purposes, while front van is painted and complete.

Case Study

Making Plastic Truck Bodies

An experiment in the "home construction" and use of glass fiber-reinforced plastic truck and trailer bodies has proved highly successful at the Antioch, Calif., plant of Seaboard Transportation Co., contract haulers and operators of a fleet of trucks serving California, Oregon, and Washington. The company has had almost fantastic success in building more than 25 van type trailers and open-top wood chip trailers out of Vibrin polyester resin with glass fiber reinforcement.

The firm uses its 300 trucks in "trains" consisting of tractors and semi-trailer combinations to haul paper, paper products, and glass. Its equipment is subjected to heavy usage in all types of weather conditions and a wide range of temperatures.

To meet the challenge of road, load, and climate conditions, Seaboard began its experiment in plastic body construction as a result of the interest of President Walter A. Junge in plastic sports car bodies. The work was carried out under the supervision of Morris Snyder, Seaboard's general manager, and Melvin L. Moore, shop foreman.

During the experimental and development period, which took slightly less than one year, the company's first product of reinforced plastic was a water therapy tub which weighs 110 pounds, holds 400 gallons of water, and costs about 25% of a conventional stainless steel hospital type therapy tub. In addition, the plastic tub does not dent or rust, and requires less expensive foundation and installation work than the metal tub.

The plunge into actual construction of plastic truck bodies came when the company's shop crew converted a 24-foot van type body on an extended-frame Trailmobile chassis (see Figure 1). This trailer, which weighs 7,110 pounds, has been in constant use for over a year with excellent results, and has shown no leakage and very litle damage. This body took about two weeks to build.

The first plastic bodies were built with stiffening ribs of 0.5-inch thin wall electrical conduit. The lower portions of these ribs, near the floor of the body, were damaged occasionally during loading of the trucks. The company then tried casting a two-foot-high plastic panel which was installed around the inside wall of the truck body, but now has shifted to using stiffening ribs built up of plastic.

Similarly, the doors initially were framed in wood, with inside and outside plastic linings. These doors now are molded as part of the truck wall itself, and then cut out. The cut-out section becomes the inner panel of the door.

The manufacturing operation begins with the design and building of molds which are made of wood, steel, and plastic in the exact sizes required. After being cut to rigid specifications, glass cloth and mat is laid up in the mold (see Figure 2) and saturated with Vibrin resin, distributed evenly with a squeegee and whiskbroom. The door headers and preformed ribs are similarly made and pressed into the wet lay-up, so that the cured piece is an integral unit (see Figure 3).

The bodies are made in sections, the sides, roof, front (see Figure 4), and floor being built separately. After curing, these sections are assembled and bonded together with resin and mechanical methods on a conventional trailer chassis.

The plastic body offers excellent resistance to damage. A sharp blow only breaks the resin surface at the point of impact, but does not damage the glass fiber. Such breaks can be smoothed off and repaired easily. Actual holes in the body can be repaired quickly and inexpensively with a putty knife, plastic grindings, and raw resin. Holes patched in this manner have about 90% of the original strength, according to Snyder, but damages can be patched and repatched indefinitely. Similar patching techniques have been used to repair holes in the company's aluminum and steel truck bodies, and have provided seals which have yet to leak or fail.

Seaboard executives believe the greatest application for their plastic bodies to be in the wood chip trailers. At the mill, these trailers are jerked up on end to dump the wood chips which sometimes are 2-4 feet in length. This is rough treatment, and trailer body damage is high. Plastic trailers weigh 7,700 pounds, as against 9,000 pounds for conventional units; are 24 feet long, with an inside clearance of more than 23 feet; are 93.5 inches wide between the walls; and are eight feet high.

The 0.25-inch plastic floor of the chip trailer is molded directly to the floor of the truck after a 1.25-inch Douglas fir shiplap base floor is anchored to the steel frame. The plastic binds the shiplap into one complete, smooth surface floor. The smooth walls and floor of the plastic trailer permit the company to palletize the wood chips and, consequently, save costs. The

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Fig. 1. Seaboard's original 12-by-14-foot plastic van body.

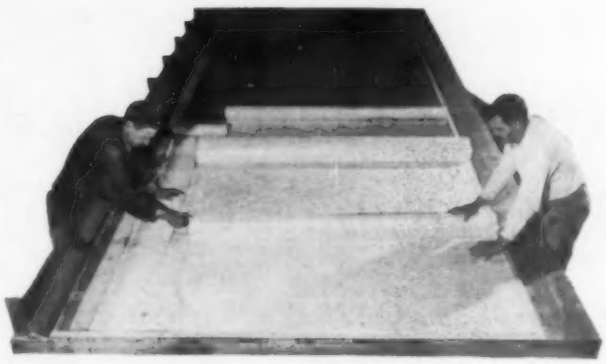

Fig. 2. Laying up the glass mat and cloth for a truck roof.

Fig. 3. Side panel being completed, with ribs and floor frame in place. Wood grain of mold shows through plastic material.

Fig. 4 Trimmed front section ready for installation.

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Use of the Repeated Hysteresis Loop for Evaluating Reinforced Plastics*

Hysteresis data obtained with repeated stress cycling give valuable information on safe working limits for reinforced plastic structures.

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Glass fiber-reinforced plastics possess high physical strengths only when the glass fibers assume the load. The degree to which the glass fibers assume the load depends upon a number of factors, including

(1) Uniform tension of the fibers.
(2) The amount of bend produced in the fiber during secondary fabrication operations, such as yarn making and weaving.
(3) The size of the unit fiber bundles.
(4) The efficiency of wetting of the fiber by the resin.

Because of one or more of the above factors, plus the added effects of moisture, only a small fraction of the initial strength of a glass fiber-reinforced polyester structure can be used as the actual working load.

Standard strength tests have been used to determine the relative worth of resins and filler structures under various conditions of temperature and humidity, and much has been learned about behavior under static load through the use of creep tests.

It is the purpose of this paper to show that such data can be supplemented by the study of the hysteresis loops and flexural modulus during repeated cycling of a specimen in flexure. In particular, this paper is concerned with the variation in safe working loads as a function of differences in reinforcing structure, and with the rate and mechanism of failure encountered.

Preparation of Samples

Three types of glass reinforcement were used in these tests: rove cloth, fabric, and unidirectional roving (see Figure 1).

Rove Cloth Samples

These samples were fabricated by saturating seven layers of woven glass roving[1] with polyester resin, stacking, and pressing to stops until cured. The woven roving contained 20-end[2] even-tension roving in the warp direction and eight-end even-tension roving in the fill direction. The laminations were laid with the warps parallel, and the specimens cut with the warp running lengthwise. The samples were post-cured at 125° C. for 16 hours prior to conditioning and testing.

Fabric Samples

These samples were fabricated by saturating 10 layers of #1000 square woven glass cloth with polyester resin, stacking, and pressing to stops until cured.

The laminations were laid up with warp and fill strands parallel. Samples were cut from these panels so that the warp yarns were parallel to the sides of the specimen. The specimens were post-cured at 125° C. for 16 hours prior to conditioning and testing.

Unidirectional Roving Samples

These samples were prepared by Owens-Corning Fiberglas Corp. The material used was a 20-end even-tension roving which was dipped in a polyester resin solution, and the resin catalyzed with benzoyl peroxide. The impregnated roving was dried for one half-hour, and oven dried at 130° F. for 45 minutes. Rods were made from five complete loops of the roving, so that each rod contained a total of 200 strands. These rods were then oven cured.

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* Based on a paper presented before the Rubber and Plastics Division, American Society of Mechanical Engineers, New York, N. Y., Dec. 3, 1954.

1 A roving is a bundle of strands of untwisted, unplyed continuous fibers.
2 The end-number is the quantity of fiber strands in each roving bundle.

Fig. 1. Types of glass reinforcements used in test specimens: (l. to r.) fabric, unidirectional roving, and rove cloth.

Testing Procedure

Repeated stressing of the samples was accomplished by loading the sample in a flexural jig mounted in an Instron tester. The jig permitted support of the sample at the center by a cylinder 0.375 inch in diameter. Two cylinders, each 0.500 inch in diameter, contacted the specimen from above and served to apply load to the specimen by moving downward with the cross-head. Load was measured by a load cell, and deflection by cross-head travel. Because load could be applied to the load cell only in tension, the specimen was stressed downward only from a neutral position.

The samples were cycled to a constant load. During cycling, a recorder drew stress-strain curves for the load and unload branches of the hysteresis loops. An electronic integrating device measured the corresponding load and unload energies.

The sample-to-sample variation encountered in the roving filled samples was small enough to allow all samples to be stressed according to the following schedule: 50 cycles at 0-39,000 psi. outer fiber stress; 50 cycles at 0-76,000 psi.; 50 cycles at 0-114,000 psi.; and 50 cycles at 0-150,000 psi.

The rove cloth and #1000 cloth filled samples, however, showed such a large sample-to-sample variation that a predetermined cycling program could not be followed. These samples were stressed for one cycle at increasing stress levels until a positive integrated loop area was obtained. Fifty cycles were then run at this stress level. Additional groups of 50 cycles each were run on these samples until failure or a total of 200 cycles had been recorded. The stress level for each succeeding group of 50 cycles was arrived at by increasing the load by 10%.

Test Results

Figure 2 shows typical hysteresis loops produced in a single load-unload cycle by samples containing different types of reinforcement constructions. The relative sizes and slopes of the loops as presented are not intended to be significant. It should be noted that each reinforcing construction produces a characteristic loop which changes little in general shape with repeated cycling or with stress level.

Figure 3 shows stress levels and associated hysteresis loop areas. The stress levels are the maxima and minima that could be maintained for 50 cycles by samples of each type of reinforcement construction. The hysteresis loop areas are the average areas produced by a sample group in 50 cycles for the corresponding stress levels.

The flexural modulus of the samples has been tabulated in Figure 4. The bar graph at the left shows the maximum and minimum moduli obtained for samples of a given type at a given stress level. The bar graph on the right shows the maximum and minimum changes in modulus for samples of a given type at a specified stress level during 50 stress cycles. It is noted that modulus is also affected most by preconditioning in water and by testing at 125° C.

Figure 5 contains a plot of the curves for typical hysteresis energy loss vs. cycle. It should be noted that both the roving and fabric reinforced sample curves have some slope, indicating that failure at the indicated stress levels will take place with sufficient cycling. The curve formed by the rove cloth sample is primarily a horizontal line. Experience in cycling these samples indicates that this may not be an indication of survival at this stress level. As has been noted previously, these samples may fail without the warning of a steady change in hysteresis energy loss. However, a decrease in modulus usually predicts failure.

Rove Cloth Samples

Although the loop produced by the rove cloth sample is somewhat similar in shape to that produced by the roving reinforced sample, it can be distinguished by the straight lines of both the load and unload portions of the loop. These straight lines are maintained to failure. The loop increases by a widening of the angle between the load and unload sides.

Samples with rove cloth reinforcement failed abruptly with either no increase in hysteresis loop area or, in some cases, a sharp increase in loop area 5-10 cycles prior to failure.

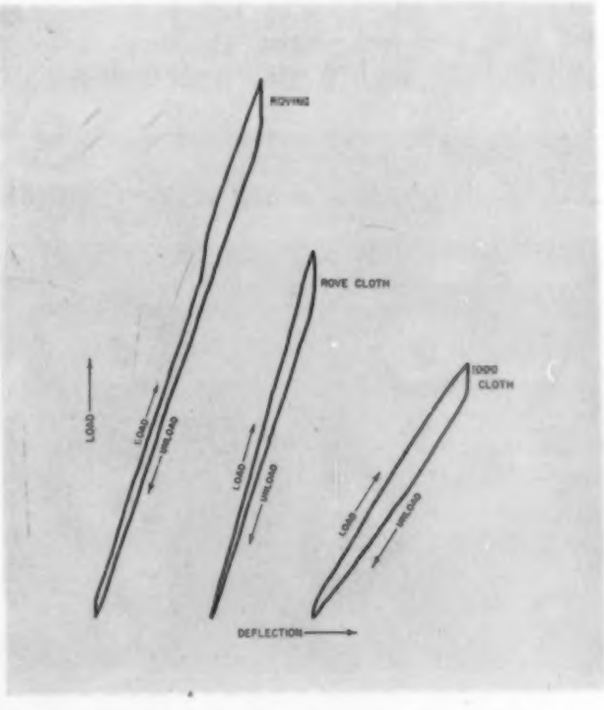

Fig. 2. Typical hysteresis loops for specimens with different glass reinforcement constructions.

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The stress levels maintained by the rove cloth reinforced samples were intermediate between the roving and fabric reinforced samples. The hysteresis energy losses were smaller generally than the losses produced by either of the other reinforcement types. The sample-to-sample variation in average hysteresis energy loss and in stress level was more pronounced than with the other reinforcement types.

The moduli of the rove cloth reinforced samples showed some sample-to-sample variation, and a moderate change with change in stress level and condition. The change in modulus with cycling, however, showed considerable variation.

Roving Reinforced Samples

The modulus change noted part way up the load portion of the hysteresis loop was present to a greater or lesser degree in all loops produced by these samples during the first 5-10 cycles at the higher stress levels. The sharp change in the slope of the curve may be caused as a large portion of the stress is assumed by a bundle of fibers under greater tension than its neighbors.

The irregularities in the manner by which the fiber bundles take stress usually are eliminated within 10 cycles at a given stress level, probably by failure of resin-glass bonds, breakage of glass fibers, and/or creep of the resin in shear allowing a more even distribution of stress. Failure of the samples was gradual, and could be predicted by the steady increase in hysteresis energy loss with cycling.

The roving reinforced samples maintained the highest stress levels and were the least affected by conditioning of all the samples tested.

Unfortunately, the equipment for testing at 125° C. was not available when these samples were tested. The hysteresis loop areas produced by the roving filled samples are intermediate in size between the rove cloth and fabric reinforced samples. The sample-to-sample variation in average loop area was extremely small.

Fabric Reinforced Samples

The fabric reinforced samples produced hysteresis loops differing from the other samples in that both the load and unload portions of the loop are curved rather than straight. These curves become more pronounced as cycling increases and, together with an increased lag at the top of the loop, tend to increase the hysteresis area. Failure in these samples is preceded by a long steady increase in hysteresis energy loss and can be readily predicted.

The samples maintained the lowest stress levels, and showed the greatest changes with conditioning. Hysteresis energy losses were higher than with either of the other reinforcement types, and were more influenced by changes in condition. The highest average hysteresis energy losses recorded during these tests were obtained by testing fabric reinforced samples at 125° C.

The moduli of the fabric filled samples showed little variation with changes in either stress level or condition (except the 125° C. test condition), but did show moderate change with cycle. When the samples were cycled at 125° C., they showed the lowest modulus of all specimens, together with the greatest modulus change with cycling.

Analysis of Test Data

Differences in the characteristic shapes of the hysteresis loops obtained from samples made with different types of reinforcing structures, together with differences in behavior under repeated stress cycling, are due primarily to the size of the effective unit reinforcement and its associated resin-glass interface.

The effective unit reinforcement is considered to be the smallest bundle of glass fibers which acts as a discrete unit in respect to stress. The effective resin-glass interface is that part of the area between the unit reinforcement and the resin which is effective in carrying shear stress without buckling.

Some indications of the orientation of the glass fibers in the different samples are given in Figures 6, 7 and 8. These Figures are photographs of the cross-sections of the samples. The effects of fiber orientation on behavior pattern are given in Table 1.

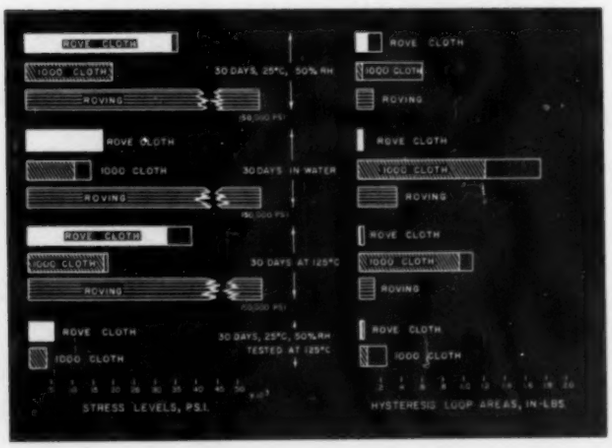

Fig. 3. Effect of reinforcement construction on stress levels and associated hysteresis loop areas under different test conditions.

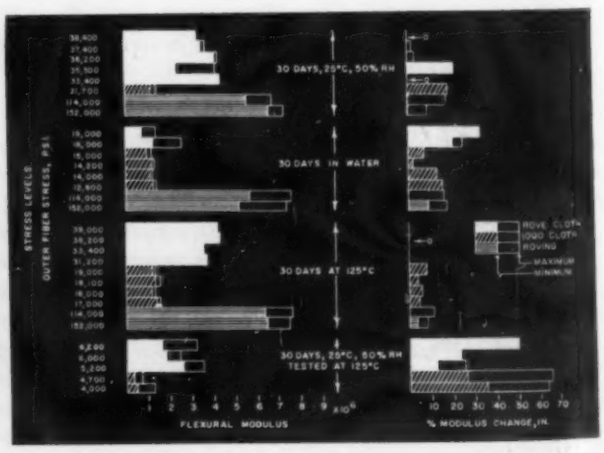

Fig. 4. Effect of reinforcement construction on flexural modulus at varying stress levels and test conditions.

Table I. Effect of Glass Fiber Type on Stress and Shear Behavior

Type of Glass Reinforcement	Degree to which Glass Fiber takes Stress	Effective Resin-Glass Interface in Shear
Roving	Very high	Very high
Rove cloth	High	Low
Fabric	Low	High

Roving Reinforced Samples

From Figure 6 it will be noted that the fibers in the roving reinforced samples are oriented in straight lines. Because all the fibers are parallel and lie close together with relatively little resin in the interfaces, and no cross ties are present, the 20-end rovings lose their identity and the effective unit reinforcement becomes the single glass fiber.

The effective interface between the fiber and its surrounding resin is large because this area is exposed to shear stress rather than to buckling. A large effective resin-glass interface in shear usually means a large hysteresis energy loss, with a gradual increase in energy loss as failure approaches. However, with unidirectional roving reinforcement the glass fibers themselves take the bending stress, and the glass-resin interface is not appreciably stressed in shear until relatively high stresses are reached. Consequently, flexural modulus is high. Until relatively high stress levels are reached, the hysteresis loss remains small.

Rove Cloth Samples

The addition of bundles of carefully oriented cross fibers, as in the case of the rove cloth reinforced samples, completely changes the hysteresis loss behavior. As can be noted in Figure 7, the cross fibers produce two effects: maintenance of each 20-end roving as the effective reinforcing unit; and displacement of these units at intervals so that they do not lie in a straight line as in the unidirectional roving sample.

Pools of resin lie between the effective reinforcing units (bundles of 20-end roving). In consequence, buckling is likely to occur with repeated stress as the reinforcing units break away from the resin pools. Tensile or compressive stresses exist across these resin pools, and flexural modulus will decrease under these conditions with repeated stress. The effective area between roving and resin in shear is small, because the large pools of resin appear more likely to fail in tension or compression (the roving actually breaks away).

Shear occurs only when a thin layer of resin exists between two effective reinforcing units. Consequently, hysteresis loss is small for rove cloth samples even after repeated stress cycling close to the breaking load.

Modulus and breaking stress are relatively high for rove cloth reinforced samples because a large amount of the glass fiber is effective in assuming stress. The fibers in the effective unit reinforcement lie in a relatively straight line as compared to fabric.

Fabric Reinforced Samples

The fabric (1000 cloth) reinforced samples present a third type of fiber orientation. In this type of reinforcing construction, as shown in Figure 8, the fibers are oriented somewhat like a spring. The individual fibers are twisted, plyed, and then kinked in the weaving process. The woven cross yarns, together with twist and ply, prevent the individual yarns from losing their identity, and the twisted, plyed, and kinked yarn becomes the effective unit reinforcement of the structure.

Because the effective unit reinforcement is kinked, it tends to compress or elongate easily. Consequently, the flexural modulus is low. Likewise, the kinked unit

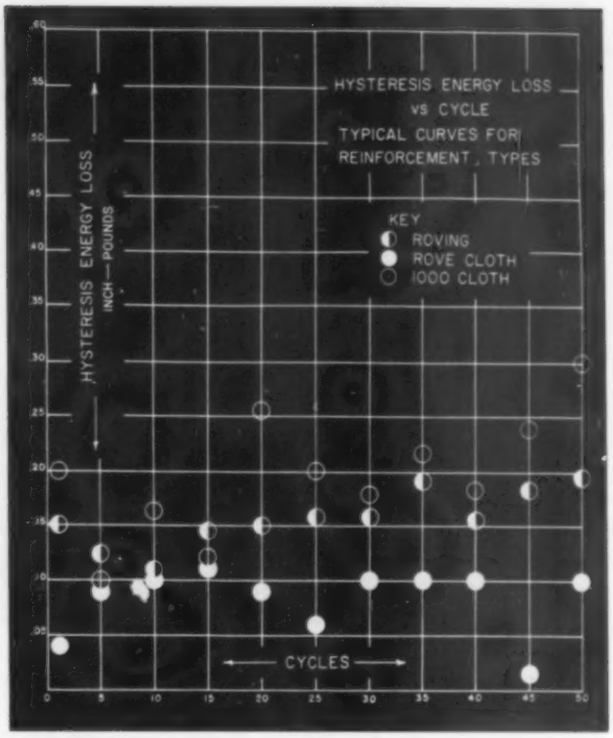

Fig. 5. Effect of reinforcement construction on hysteresis energy loss at different test cycles.

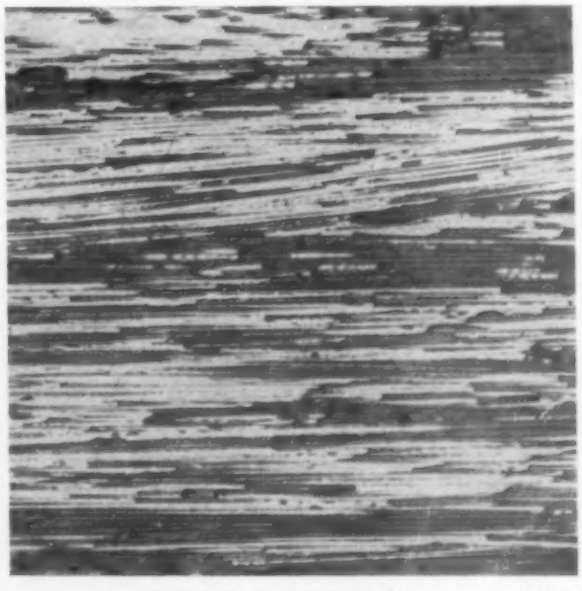

Fig. 6. Cross-sectional photomicrograph of roving reinforced sample. (Magnification, 75X).

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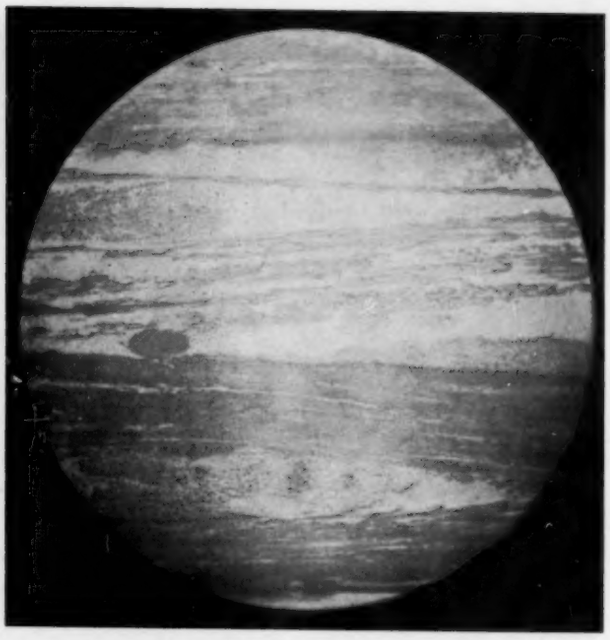

Fig. 7. Cross-sectional photomicrograph of rove cloth reinforced sample. (Magnification, 50X).

Fig. 8. Cross-sectional photomicrograph of fabric reinforced sample. (Magnification, 50X).

reinforcement does not tend to buckle and break away from the resin as much as in the rove cloth. Since the shear stress adjusts itself during repeated stress cycles, small portions of the area in shear will fail and the resulting smaller total area is more highly stressed, so that there is a larger hysteresis loss.

Conclusions

The magnitude of the resin-glass interface placed in shear varies with different sample constructions and controls the behavior of the samples under repeated stress. Hysteresis energy loss provides a means of measuring the effect of stress at the resin-glass interface. With repeated stress cycles, measurement of hysteresis loss provides a means of following the changes occurring at this interface.

Flexural modulus indicates the degree to which the glass fibers take stress in tension and compression. With repeated stress cycles, changes in flexural modulus indicate changes in the ability of the glass to take load, i. e., broken fibers, loosened fiber bundles, etc.

Analysis of hysteresis loss, combined with an analysis of flexural modulus during repeated stress cycling at increasing loads, provides an effective method of comparing different constructions of reinforced plastics and the effects of conditions likely to be encountered in service.

It is believed that such data are far more helpful in determining safe working limits for structural plastics than standard physical tests.

—The End

Effects of Thermocouple Location and Wattage Control on Injection Cylinder Temperature (*Cont'd. from page 281*)

area of the cylinder under exact regulation at all times.

It should be noted that standard IMS thermocouple locations were used on these tests. These locations can only be considered as standard relative to the type of clamp ring and rear flange diameter used on the Reed 8 machine, and to no other.

Conclusions

Considerable progress has been made recently in molding materials and in heating cylinder design. Unless these two areas of research are first correlated through the use of fully effective controls and correctly applied related pyrometer equipment, expected benefits to the molder (and to the consumer in the form of better molded articles) can be delayed unnecessarily. Good heaters can have their performance spoiled by improperly used controls, or by good controls being used in an insufficient number to regulate new, higher wattages.

Good controls that are applied improperly can add costly variables that will be unknown to the molder until they are finally reflected in his scrap rate or, unfortunately, molded into his products.

When this occurs, the effects of these misused molding heats usually do not appear until the products are in service. Then they crop up in the form of crazing, cracking, embrittlement, and failure to withstand detergents, hot water, freezer temperatures, and even normal use. When this occurs, the molder, the instrument maker, and the equipment supplier all suffer the ire of the consumer who damns all plastics because a few poorly molded articles have failed to perform as they should.

Acknowledgment

Acknowledgment is due R. W. Channell, of Wheelco Instruments Division of Barber-Colman Co., for the test runs and tabulations which form the basis for this paper.

—The End

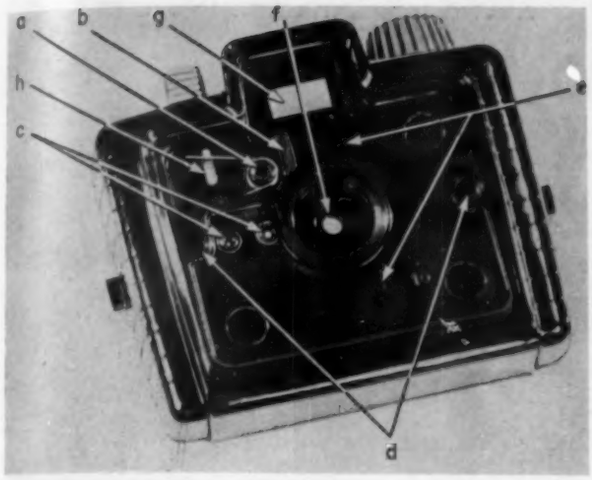

Figure 1. Front view with face plate and lens removed. Letters are explained in the accompanying text.

Figure 2. Roll holder of black phenolic is molded in one operation

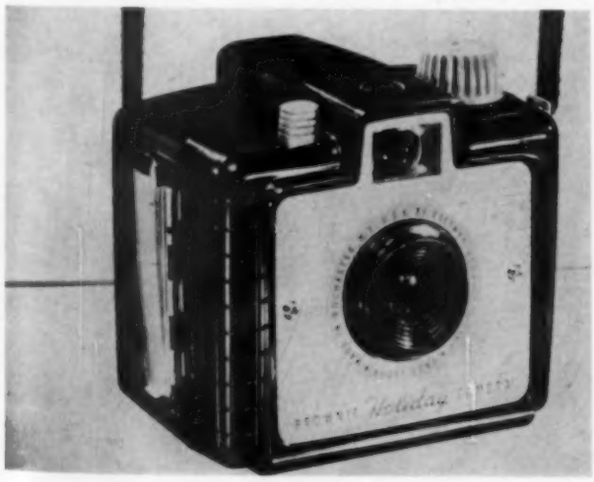

Figure 3. Assembled camera represents a compact, cubical box.

Auburn Revamps Brownie Camera

The new Brownie "Holiday" produced by Eastman-Kodak Co., Rochester, N. Y., represents a far cry from the first Brownie with its strawboard box and pinhole lens. Auburn Button Works, Inc., Auburn, N. Y., developed and designed today's Holiday, taking full advantage of the intricate design features afforded by plastic molding techniques.

Case and front wall of the new model are molded phenolic, chosen for its durability and dimensional stability. Since tolerances can be held to 0.003 inch, a light-tight camera is insured which is resistant to temperature and humidity. By the use of side draws in the die, Auburn was able to mold undercuts, side recesses, and holes which would otherwise require machining. Examples include provisions for the shutter, interior box mounting, slide locks, and lens locks.

A molded ridge around the perimeter of the case fits into a corresponding channel on the other half, making the case impervious to the entrance of light. This tongue-and-groove design would be prohibitively expensive to form by any other method than plastic, and is further evidence of design economy afforded by plastics. The inner surface of the case and the roll holder box are sand blasted to remove the glossy surface, thus preventing glare spots from registering on the film when the shutter is snapped.

In addition to the phenolic parts previously mentioned, the camera also includes a butyrate lens holder, film-turning knob, and shutter button. The viewfinder lens is molded from clear methacrylate. Thirty-five components in all are required for the Holiday, a considerable decrease as compared with previous models. Several secondary operations were eliminated, and assembly labor time was reduced to a minimum.

Figure 1 shows the detailed design features made possible by molding. Molded stud (a) holds wire spring which returns shutter to position. A circular boss around the shutter opening serves as the lens mount seat, and the adjoining plastic rib (b) matches a slot in the lens mount to hold and index the lens. Two knurled posts for inner shutter parts have been driven from the rear into the two pre-molded holes (c) at the left of the lens opening. Two holes (d) are also formed for self-tapping face plate screws, and two more (e) for mounting the wall to the front of the case. Also provided are openings for the main lens (f), viewfinder lens (g), and slot for trigger action (h).

—The End

UNIVERSITY MICROFILMS

Photos by Guth

Guest Editorial

What is the Future of Polyethylene?

WILLIAM P. MARSH, JR., *Vice President of National Distillers Products Corporation, and Assistant General Manager of U. S. Industrial Chemicals Co. Division New York, N. Y.*

During the past ten years polyethylene has grown from a wartime baby to a full-fledged giant, and shows every sign of continuing its growth. National Petro-Chemicals Corp., along with its two parent companies, National Distillers Products Corp. and Panhandle Eastern Pipeline Co., has demonstrated its faith in the future of this versatile plastic with the start-up during February of a new polyethylene plant at its petrochemicals plant site in Tuscola, Illinois.

Industry prophets have predicted that polyethylene will be the first billion-pound-per-year plastic, and that consumption will reach that figure somewhere around 1965-70. With the announced expansions of Bakelite and DuPont essentially complete, and the new production facilities of Allied, Dow, Eastman, Monsanto, Spencer and our own company either complete or well under way, production capacity by the end of this year is expected to be somewhere in the 550 million-pound-per-year range.

"Polyethylene may well become the first billion-pound-per-year plastic."

Although demand for polyethylene is expected to increase rapidly, it is not expected to jump quite so sharply as production capacity. Market requirements for 1955 have been variously estimated at 300 to 350 million pounds, and requirements for 1956 at something over 400 million pounds. Demand, according to the forecasters, will not reach the above production capacity until about the end of 1957. Thus, it appears that the industry will suffer something of an overproduction problem during the next two years.

We expect the problem to be somewhat tempered, though, by three factors: (1) Many of the new producers will not be in a production for the entire 1955 year; (2) the new plants will have their start-up troubles, and a considerable quantity of polyethylene produced during the start-up period will probably never be released to normal market outlets; and (3) the ability of this country's plastics processors to find uses for the available polyethylene might well have been underestimated.

We feel this last point to be, perhaps, the most important. Consumption of polyethylene has grown at a fantastic rate during the past 10 years despite a shortage of resin during most of that period. Now that the supply is more than adequate, processors anad fabricators can give free rein to their creative instincts and introduce product after product that the consuming public is ready, if not anxious, to accept. Such modified forms as chlorinated, chlorosulfonated, and irradiated polyethylene give development personnel an even broader range of raw material properties with which to start. We are confident that the fertile imagination of plastics processors, which has been so well demonstrated in the spectacular growth of the entire plastics industry, will meet the challenge of over-supply and will locate markets for the entire polyethylene resin production within a relatively short time.

When demand and supply become equalized, we can look forward to a healthy polyethylene market. Producers will expand as required to keep pace with the demand. Consumer prices will probably decrease with healthy competition and increased manufacturing and processing volume and know-how. This, in turn, will further spur polyethylene demand, especially in the pipe and bottle fields.

In that balanced, competitive market, we foresee that the integrated polyethylene resin producer will enjoy several advantages over his non-integrated competitor. The plant with a captive ethylene source will more easily maintain a satisfactory profit margin under a competitive price structure. Then, too, the integrated plant that can divert a good part of its unreacted ethylene to other processes, such as ethylene glycol or ethyl chloride, all other things being equal, can expect to maintain a quality edge and thus either a sales or a price advantage.

In general, then, we feel that though the next two years may be slightly difficult for newcomers in polyethylene production, such as ourselves, the future looks bright enough for everyone in the field to more than justify the many millions of dollars spent during the past few years for new and expanded production, processing, and fabricating facilities.

—THE END

"Production will probably overshadow demand until 1957, creating a definite over-production problem."

"Polyethylene consumption has grown at a fantastic rate during the last decade despite material shortages."

"The plant with a captive ethylene source should profit under a competitive price structure."

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Plastics as Capacitor Dielectrics - 3. Polystyrene

The third of a five-part series on plastics being used as dielectrics or insulators in the electrical industry

GEORGE MISTIC, *Director of Research*
Condenser Products Company, Division of
New Haven Clock & Watch Co., Chicago, Ill.

Polystyrene, a non-polar material as is polyethylene, is a pure hydrocarbon with a phenyl group replacing one of the hydrogen atoms in the ethylene molecule. Owing to the presence of this phenyl group, polystyrene plastic is inflexible. However, developments here and abroad have overcome this obstacle of rigidity by stretching the material in two directions during film manufacture. This double orientation imparts flexibility to the plastic so that it remains flexible over an extremely wide temperature range. Films up to 0.4-mil thick are made so flexible that they can be used to wind capacitors as easily as with paper.

Styroflex, a double-oriented film, was first made available in Germany where much use was made of the film as a capacitor dielectric and cable insulation. Styroflex found extensive use as an insulation for coaxial cable and high and ultra-high frequency lines where low dielectric loss was mandatory. It was found that the spirally wound insulation on coaxial cable produced an even lower loss than does the polyethylene insulation currently in common use throughout the industry.

Condenser Products engineers utilized this film for capacitors many years ago in order to fulfill requirements for a particularly low loss capacitor with extremely high insulation resistance. Their research into the properties of this high quality dielectric showed that it had several outstanding properties which at that time no other dielectric had, such as low temperature coefficient of capacitance, extremely good capacitance stability, low drift, and high dielectric strength for DC applications and pulse networks for radar use.

During World War II, high quality mica became very difficult to obtain and a substitute was needed immediately to meet this shortage. It was found that polystyrene could, in several instances, equal or exceed the characteristics of mica in those applications where stability, low loss, and high insulation resistance were particularly important.

Further research has shown that although polystyrene is attacked by ordinary impregnants, certain viscosities of dimethyl silicone were compatible when properly processed. Thus, the high dielectric strength of polystyrene could be utilized for high voltage applications.

General Characteristics

Generally speaking, certain minor differences are noted between the various types of polystyrenes used for electrical purposes, depending upon the method of processing by the plastics manufacturer. It was found that certain types of lubricants (such as phenanthrene) when used on polystyrene during manufacture radically reduced the effects of moisture absorption on the power factor of the plastic. On the other hand, it was found that additives to polystyrene affect the dissipation factor and lower the breakdown voltage. Therefore, a high purity polystyrene is essential for best electrical characteristics, and a hermetically sealed unit prevents any

deleterious effects that may be caused by external environmental conditions.

The material used throughout this work is a high purity polystyrene which has been stretched in two directions during manufacture and, upon cooling, orients the molecules in these two directions. Such a configuration of the plastic produces a film of unusual mechanical and electrical properties.

The material is extremely strong, having a tensile strength of 10,000 psi. The water absorption, according to ASTM tests, is less than 0.1% maximum, and the moisture vapor transmission rate is less than three grams per 100 square inches per 24 hours at 74° F. The resistance to strong acids and alkalies is quite good, but the resistance to organic solvents such as carbon tetrachloride and benzene is quite poor. Hydrocarbons such as mineral oil will also dissolve this material.

Films as thin as ½-mil have been developed, but the number of conducting paths or pinholes is greater in thinner films. The one-mil-thick Styroflex contains a maximum of only two conducting paths or weak spots per 100 square inches of film. However, when used as a double layer of film, the number of conducting paths is not as essential to the dielectric strength, since no two conducting paths will line up in a double layer. Thus, the chances for breakdown and the percentage of rejects will be less when more than two layers of any plastic film are used. It is found that Styroflex in very thin films can be used in a single layer without the reject rate being greater than 20% when winding one-microfarad units. A typical capacitor winding operation is shown in Figure 1.

Temperature and Frequency

Although the effects are not appreciable, temperature and frequency do affect the dissipation factor and dielectric constant of polystyrene. For instance, at –40° C. and one kilocycle the dielectric constant is 2.58 and rises linearly to a value of 2.55 at 75° C. At one megacycle, the dielectric constant is approximately 2.5 at room temperature.

Temperature also affects the dissipation factor. For instance, at 0% relative humidity, –40° C., and one kilocycle, there is a sudden change in slope due to a sudden change in viscosity of the Styroflex.

Fig. 1. Winding of polystyrene film between layers of aluminum foil to make capacitors.

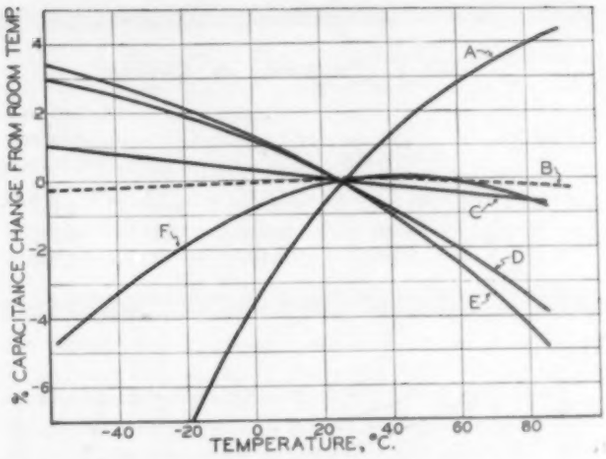

Fig. 2. Effect of temperature on capacitance change: A—silicone oil-impregnated cellulose acetate; B—unimpregnated mica; C—unimpregnated polystyrene; D—silicone oil-impregnated polyethylene; E—unimpregnated polyethylene; and F—mineral oil-impregnated paper.

In order to obtain an extremely good dissipation factor and very low losses, it cannot be too severely stressed that moisture must be excluded. For instance, a unit that contains absolutely no moisture has a dissipation factor at one kilocycle and 25° C. of 0.00012. With 40% relative humidity the dissipation factor rises to 0.00023, and at 90% relative humidity the dissipation factor rises to 0.0004. However, lubricated polystyrene (containing a lubricant such as phenanthrene) has a much lower dissipation factor with an increase of relative humidity.

As can be seen from Figure 2, the capacity change with temperature at one kilocycle is extremely low, decreasing less than 2% from –60° to 85° C. Unimpregnated polystyrene has less capacitance change with temperature, whereas silicone-impregnated polystyrene has a somewhat larger percent capacitance change with temperature. It should be noted that the silicone-impregnated polyethylene and cellulose acetate values on this curve are extremely large in capacity change with respect to temperature compared with polystyrene. The temperature coefficient value for polyethylene is a negative 650 PPM/° C., and that for polystyrene is an average negative 130 PPM/° C. although certain physical configurations will yield less than 100 PPM/° C. The percent capacity change for mica is extremely small, and is at all times a negative 30 PPM from a 25-85° C. temperature range.

Dissipation Factor and Q-Value

The Q-value (reciprocal of the dissipation factor) of polystyrene was found to be better than that of mica capacitors and very much better than that of paper capacitors. Table I indicates the various frequencies at which the Q-value was measured for polystyrene, mica, paper, and polyethylene capacitors of equivalent capacitance and voltage ratings at room temperature.

Table 1. Frequency vs. Q-Value

Frequency, Kc.	Polystyrene	Mica	Paper	Polyethylene, Silicone Impregnated
1	12,000	3,200	500	4,000
10	11,500	6,000	450	4,300
100	8,500	6,500	200	4,200
1000	4,000	1,500	75	3,100

From this table it will be seen that the Q-value or reciprocal dissipation factor is higher for polystyrene than for mica, polyethylene, or paper. In addition, the Q-value remains higher to frequencies greater than one megacycle, above which the Q-value of polystyrene decreases rapidly.

Capacitance Stability

The drift of room temperature capacitance with temperature cycling from −50 to +85° C. is a criterion of the stability of the capacitor due to fluctuations in environmental conditions. Not to be confused with the temperature coefficient of capacitance which is a temperature effect upon the dielectric constant, the drift and stability of a capacitor with temperature depends on the construction and aging of the capacitor. A capacitance bridge test is shown in Figure 3.

Polystyrene was compared with an equivalent mica capacitor and a paper capacitor. Two types of temperature cycling were given the capacitors, and the percent change in capacitance from the start of the testing was noted. In general, it can be stated that for temperature cycling from −60 to +70° C., the room temperature capacitance of the polystyrene unit will not shift greater than 0.05% after 10 temperature cycles of this type. Figure 4 illustrates the percent capacitance change with the number of hot and cold cycling conditions.

For temperature cycling from room temperature to 75° C., the mica capacitor exhibited 50% less capacity change than the polystyrene unit. The minimum percent capacitance drift of the polystyrene units for 30 high temperature cycles was 0.07%.

Fig. 3. Capacitance bridge test of polystyrene capacitor. Test measures capacitance and power factor.

Dielectric Absorption

The residual voltage build-up after a charged condenser is discharged should be as small as possible in a high quality capacitor. This residual voltage is expressed as a percent of the initial charging voltage. Several investigators have shown in previous experiments that temperature, charging time, and shorting time affect the percent absorption voltage. All things being equal, it was found that polystyrene has the lowest percent absorption voltage of any widely used dielectric material.

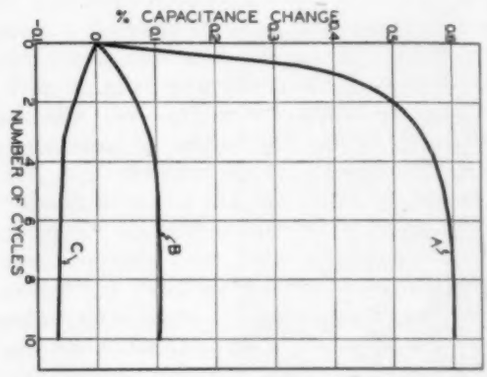

Fig. 4. Effect of temperature cycles on capacitance drift: A—mineral oil-impregnated paper; B—unimpregnated mica; and C—unimpregnated polystyrene. Each cycle consisted of 18 hours at —60° C., 18 hours at 25° C., 10 hours at 70° C., and 18 hours at 25° C.

In general, it can be stated that the longer the time of shorting of a charged capacitor, the less will be the absorption voltage recovery. Also, all other things being equal, the recovery voltage will be larger the longer a condenser is charged. However, the recovery voltage of a condenser charged for one week will be close to double that of the recovery voltage of a condenser charged for one hour.

It can be stated also that a capacitor charged for one hour and discharged for several seconds will generally build up its voltage fairly linearly on a semi-log time base, but for all practical purposes the absorption voltage reaches a practical maximum within five minutes if charged for one hour and discharged for one second. For all voltages, the capacitor will attain a maximum absorption voltage of approximately 0.05%, but not exceeding 0.1%, in 30 hours after the shorting period. Also, at temperatures of 70° C., the percent absorption voltage will not exceed 0.1%.

Note that in Figure 5, in which the condenser is charged to 75 volts DC for five minutes, then shorted for one second, the recovery absorption voltage is quite rapid for the first 30 seconds after the temporary short, then levels off and reaches a near maximum within five minutes.

As shown in Figure 6, polystyrene exhibits less residual voltage build-up than a mica or a polyethylene

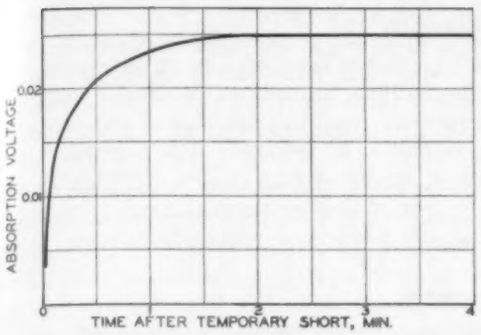

Fig. 5. Effect of time after temporary short on absorption voltage build-up of polystyrene at 25° C. Capacitors charged for five minutes at 75 volts DC.

capacitor. Although it is not shown, a mineral oil-impregnated paper capacitor is 50% greater in all values than the mica capacitor. These values were obtained after one minute from shorting of the capacitor where shorting time is indicated on the abscissa. In all cases, 150 volts was used and capacitors were first charged for 30 seconds before shorting. It should be noted that although these condensers were charged for 30 seconds, values approximating these absorption voltages were found when the capacitors were charged for periods up to one hour.

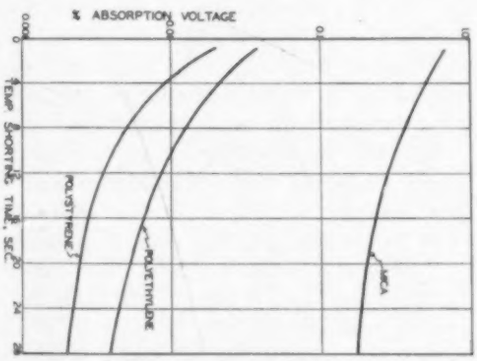

Fig. 6. Effect of shorting time on the absorption voltage of polystyrene. Tests made one minute after shorting of capacitors charged for 30 seconds at 150 volts DC.

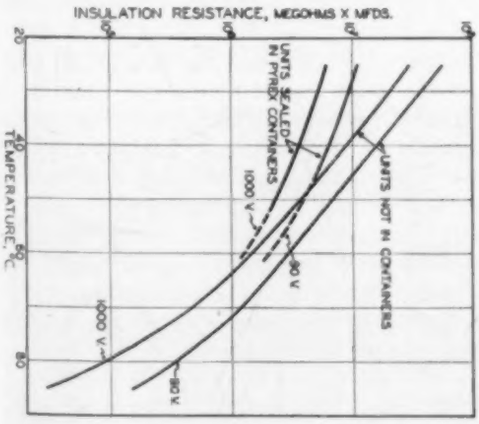

Fig. 7. Effect of temperature on insulation resistance of Styroflex. Capacitors charged at 90 and 1,000 volts, and tested both in and out of glass containers.

Insulation Resistance

One of the outstanding characteristics of Styroflex dielectric is its extremely high volume resistivity and the consequent extremely low conduction currents found in polystyrene capacitors. For example, if a specially processed polystyrene condenser is charged and then allowed to discharge through its own internal insulation resistance, it takes approximately 25 years for the condenser to discharge to one-half its charge voltage.

However, it must be stressed here that high insulation resistance of a capacitor can be realized only when the capacitor is properly processed to eliminate moisture, and is then hermetically sealed. Also, the insulation resistance of the container and the terminals is of major importance in developing capacitors whose high insulation resistance is the primary characteristic.

Normally processed capacitors which are hermetically sealed in metal or glass containers using high insulation resistance ceramic terminals will have an insulation resistance better than 30 x 10^6 megohms x microfarads. Condensers that are less than one microfarad and have required insulation resistance values of greater than 10^{14} ohms must have specially processed terminals or be placed in containers. Such condensers include polystyrene, polyethylene, and Kel-F which must be inclosed in order to reduce surface charge leakage.

The effects of voltage on insulation resistance on polystyrene are fairly slight. Figure 7 illustrates the insulation resistance variation with temperature at several voltages. Note the effects on insulation resistance of placing a section into containers of pyrex glass tubes as compared with sections alone at the lower temperatures.

Polystyrene units have a capacitance of 0.01 microfarad have been placed in special plastic tubes in order to obtain an insulation resistance of greater than 10^{14} ohms at 70° C., using 400 volts electrification. Correspondingly, a one microfarad unit at this temperature would have an insulation resistance of better than 1,000,000 megohms.

The effect of x-ray irradiation on Styroflex is to de-

Fig. 8. Flash testing of polystyrene capacitors at 1½ times rated voltage. Test weeds out capacitors that may short out under surge voltages.

crease its volume resistivity. Removing the source results in a fairly rapid recovery of the volume resistivity. Kel-F is least affected by irradiation, followed by Teflon and then polystyrene.

Dielectric Strength

The properties of one-mil Styroflex film indicate that the dielectric strength is 5,000 volts per mil, using ¼-inch electrodes and rapid rise of voltage to breakdown. In order to obtain a safe working voltage where the capacitor is to operate for thousands of hours at temperatures of 65-85° C., this voltage must be reduced to approximately 1,000 volts per mil at 85° C. Impregnation with dimethyl silicone increases this voltage rating and the life of the capacitor.

The breakdown strengths of polystyrene at frequencies of 60 cycles to 100 megacycles are such that there is a large drop in dielectric strength with an increase in frequency. The dielectric strength of a dry sample 30 mils thick at 60 cycles is approximately 1,700 volts per mil, and at 10 megacycles is approximately 150 volts per mil. The 60-cycle corona resistance of polystyrene was found to be only slightly better than that of polyethylene, and very much better than that of Teflon, but impregnation with dimethyl silicone improves the corona resistance of polystyrene.

Polystyrene impregnated with dimethyl silicone is suitable for R.F. applications, and especially for those applications where low losses are required and peak pulse voltages are encountered, such as in pulse forming networks for radar circuits. A flash test for surge voltage is shown in Figure 8.

Applications

Because of its high insulation resistance, polystyrene is an ideal capacitor dielectric where an extremely long time-constant is required and a charge is to be accumulated over a long period of time, such as in electrometer circuits and charge measurements. The low absorption voltage of polystyrene capacitors makes them ideal for uses where a small residual voltage may unbalance a circuit and give false readings. Because of the advantage of low absorption voltage, polystyrene capacitors have found use in circuits requiring charge storage and low residuals such as direct-reading spectrometers for spectro-chemical analysis, counting devices, and computing devices.

With its low dissipation factor and high Q-value, polystyrene is able to supplant mica in several instances where a high Q-value and low loss capacitor is required, such as in pulse forming and de-spiking networks, and filter circuits. Since polystyrene has a high volts-per-mil rating and is compatible with dimethyl silicone, it is an ideal capacitor for high voltage direct-current applications and for R.F. applications where temperatures do not exceed 88° C. Because of its excellent stability characteristics, polystyrene finds extensive use in secondary capacitor standards and decade condensers, as well as in R.C. circuits and frequency standards.

Conclusions

Polystyrene has been used as an insulation for electrical applications for over 40 years, and many years of field experience with this material as a capacitor dielectric have proved its reliability. The fact that it provides a plentiful supply of high quality dielectric to supplant mica in case of another national emergency places this material in a position of primary importance.

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—THE END

Engineering Properties of Plastics for Building
(*Cont'd. from page 289*)

mum sunlight and provide a feeling of spaciousness. Transparent and translucent panels with structural qualities are highly desirable for such buildings.

Sandwich panels having a combination of structural attributes and light transmission are being developed for these purposes. Such panels can carry at least part of the superimposed floor and roof loads and they are sufficiently strong to withstand wind pressures.

In this connection the ready formability of plastics should allow for the development of structurally efficient shapes providing light-transmittance and, at the same time, sufficient shading to prevent overheating of interiors by bright sunlight. The solar load can become a major problem in buildings with light-transmitting walls. Outward heat loss is another problem for which double-walled units could help to provide a solution.

A fourth major trend is the increasing importance of mechanical and electrical equipment for such purposes as air conditioning, illumination, power, and the multiplicity of services required in a modern building. This is coupled with the necessity for flexibility of this equipment to accompany the flexible planning associated with large open areas.

When space is rearranged, the mechanical and electrical services must also be rearranged. Flexible piping, conduit, cable, and ducts are required; continuous electrical outlets are desirable; and luminous ceilings are often called for. The open planning and lightness of construction involved pose problems of thermal insulation and acoustical control, which must often be combined with overall illumination in ceilings. To all of these problems plastics can make a decided contribution if they are used with imagination and understanding of their possibilities and limitations.

Summary

This paper has attempted to set forth the ranges of strength, stiffness, thermal properties, corrosion resistance, and durability of plastics in comparison with the

familiar metals, wood, and concrete used in building. It has briefly touched upon the engineering aspects of laminates, reinforced plastics and sandwiches. It has attempted to show the major trends occurring in building design and to indicate how plastics fit into these trends.

One conclusion should be clear. Plastics possess their own combinations of advantages and limitations which set them off from other materials. Attempts to use them like other materials are likely to produce unhappy results, and are certain to fail to use them most advantageously. Properly and imaginatively used, with an intelligent understanding of their properties, they can contribute significantly to the advance of building technology and design.

—THE END

Making Plastic Truck Bodies

(Cont'd. from page 289)

plastic chip trailer can be built in 10 days from the bare frame. A plastic van type trailer requires two weeks' work by two men to build (see Figure 5).

Seaboard also has experimented with the use of color in the plastic, since unpainted material admits about 70% of the ultra-violet rays so that the body interior may become uncomfortably warm. Paint cuts down this temperature effect so that the interior of the body can be cooler than the outside temperature. A window effect is obtained by not painting an area of the plastic. The company has been endeavoring to incorporate color directly into the plastic and thereby avoid painting, but is hampered by the lack of technical data and processing information.

The company has developed a glass mold for pouring plastic truck doors. This mold has a 0.25-inch plate of glass which is mitred into a four-by-eight-foot box. The glass produces a laminate which does not reproduce the grain of the wood box, and is more attractive in appearance. Seaboard has also built a small truck body by molding it in one piece, using a mold which required some 30 days to make.

The latest plastic van built by the company is 35 feet long (see Figure 6). The right side of this trailer consists of seven rolling plastic doors. The left side is a one-piece panel measuring 35 feet by eight by 0.5 feet, and is believed to be the largest hand-molded sheet ever made.

Junge, Snyder, and Moore are convinced that the plastic truck body has great potential for haulers of dairy and cream products, and other items requiring refrigeration. They note that even with their limited knowledge of the materials and techniques involved, truck bodies can be built of plastic more cheaply than they can of other materials.

—THE END

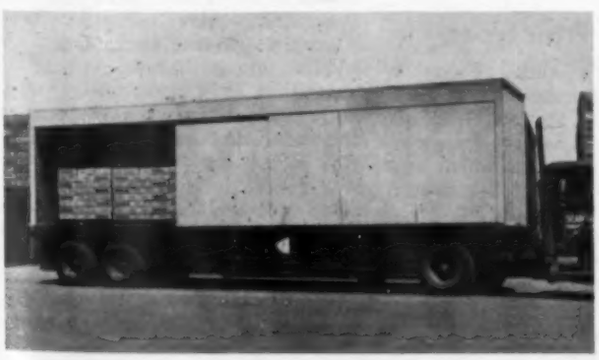

Fig. 6. Latest plastic van has rolling doors forming one side.

Koroseal Joint for Clay Sewer Pipes

Koroseal rings molded to the shaft and bell ends of clay sewer pipe

Recently developed Koroseal molding compounds have proved successful as joint sealers between lengths of pipe. A new application of this principle finds Koroseal rings molded permanently to the outside surface of the shaft end of clay sewer pipes, and to the inside surface of the bell ends. The two ends are pushed together to form a water-tight compression seal.

This new development affords a solution for cities and towns with overtaxed sewage disposal systems which become flooded by ground water seepage into the sewer lines. Another problem which is reportedly overcome involves tree roots which break into the lines, usually through weak, leaky joints.

Produced by the B. F. Goodrich Company Industrial Products Division, the new compounds are supplied in liquid plastic form to the various pipe manufacturers who process the material into flexible but tough sealing rings. The finished joint is said to be unaffected by chemicals, alkalies, and acids which are encountered in underground service. The materials are specially processed to remain flexible at low temperatures, yet remain sufficiently firm in the hottest weather.

Easy to install, the rings obviate the necessity of caulking by conventional methods. The new product is expected to become available on a do-it-yourself basis; however, distribution is currently limited to contractors. Licensed sewer pipe manufacturers are producing pipe in diameters of four, six, eight, and twelve inches; larger pipe to be available in the near future.

—THE END

GENERAL MOTORS TECHNICAL CENTER LIBRARIES

News of the Societies

Thermoplastic-Thermoset Panel

The New York Section, SPE, attempted to answer the question of "Which Plastic Material to Choose—Thermoplastic or Thermoset?" at its May 18 panel meeting at the Gotham Hotel, New York, N. Y. Approximately 100 members and guests attended the meeting which saw T. Earl Dudney, Eastman Chemical Products, Inc., and E. Y. Wolford, Koppers Co., Inc., representing the thermoplastic materials; Edward F. Borro, Durez Plastics & Chemicals, and J. Moylan, Barrett Division, Allied Chemical & Dye Corp., as protagonists for thermosetting plastics. Guy A. Martinelli, Sylvan Plastics, Inc., served as moderator.

According to Mr. Borro, the decision must be reached in the first stages of engineering. The choice, too, must be made from among many materials within a category; for example, there are over 100 active phenolic materials with 18,600 different combinations possible. As a general rule, thermosetting materials are applicable where electrical properties, dielectric strength, dimensional stability are required. Corrosion resistance and low price are two other prime factors.

The second speaker, Mr. Dudney, cited as factors influencing material choice: service requirements, part design, material limitations, and economics. He described a situation where thermoplastic material is now being recommended over thermosetting; butyrate phones in color. Another reported advantage of the new phone is that it has an average injection cycle of under one minute.

Mr. Moylan felt the controversy as applied to his company's products involved urea and styrene in decorative housings. Urea, in his estimate, showed greater resistance to scratching and crazing, was self-extinguishing, did not collect electrostatic dust, and was resistant to cold flow.

A combination of properties should determine the final choice in Mr. Wolford's opinion. He distributed property charts on 15 plastics manufactured by Koppers as a handy reference tool. Low pressure-modified polyethylene will have a tremendous impact on the industry, he felt, and competing materials will be forced to undergo modifications and improvements. This represents the cycle of choice; a different material is produced and gains favor for a time until the old is modified. The important factor in competition should be that it upgrade plastics.

Table favors were supplied by Plastic Molding Powders, Inc., and door prizes, compliments of Monsanto Chemical Co. and the Section.

Western New England Section Addressed by Reinhart

Frank W. Reinhart, National Bureau of Standards and SPE national president, addressed the May 4 meeting of SPE's Western New England Section at Bradley Field's Terrace Dining Room, Windsor Locks, Conn. A turnout of 85 members was reported.

A "three-point program" was outlined by Mr. Reinhart for developing the necessary goals to make SPE a dominant force behind the growth of plastics technology. Three areas of concentration were defined, based on the initials S, P, and E: service to industry and the public through plastics engineering; professional status for the group; and education of potential plastics engineers through recruitment and guidance programs at the college training level.

The first technical speaker of the evening, Gordon Seiter, F. J. Stokes Machine Co., spoke on the vacuum metalizing of plastic parts. Using visual aid slides, he outlined advantages and advances of the process particularly as applied to vaporization of aluminum strips by electrically-activated tungsten elements in a vacuum chamber. The latest types of vacuum equipment were also evaluated.

"Industrial Applications for Metallized Conductors" was the topic of an address by Harold Narcus, Electrochemical Co., who exhibited a number of metallized and electroplated industrial items. Emphasizing the electronics field, Dr. Narcus described printed circuitry and the use of conductive paints for plating work.

Newly elected officers for the coming term were announced as follows: president, Arthur W. Logozzo, Nutmeg Chrome Corp.; vice president, Lewis H. Gustafson, Pro-phy-lac-tic Brush Co.; secretary, Raymond A. Mazur, American Cyanamid Co.; and treasurer, Edward J. Sweeney, Rogers Corp.

Ferrari Discusses Prototypes

Edward Ferrari of General Electric's appliance division addressed the May 11 meeting of the Newark Section, SPE, on "Making of Prototypes." Seventy members and guests attended the meeting which was held at the Military Park Hotel, Newark, N. J.

The making of prototypes was described as a service to the designer, in furnishing him with a three-dimensional model at a reasonable cost and in a reasonable length of time. This need was first filled by clay and plaster models, which are now replaced by plastics owing to their greater durability.

Rigid plaster molds and PVC plastisol molds are the two most commonly used; however, reinforced epoxy and Cardolite resins are employed for special applications. The first casting resin was phenolic, which presented difficulties in parting. Epoxies can be poured and cured at room temperature, but have low heat resistance. Furan casting resins are now used for high temperature applications.

Since metal molds are difficult to produce and require skilled craftsmen, a new hammering block of reinforced epoxy resin was developed. Two new ideas in this field are metal plating on epoxy for simulated models, and metal plating into epoxy molds with subsequent removal of the metal part. Vacuum and post forming were also discussed.

AIChE Features Epoxy Resins

F. S. Swackhamer, Shell Chemical Corp., addressed the May 24 meeting of the New York Section, American Institute of Chemical Engineers, on the topic of "Epoxy Resins." The meeting, which was held at the Brass Rail Restaurant, also featured a Beer Mixer and the election of Section officers for 1955-1956.

The epoxy presentation actually took two forms: an illustrated discussion of the chemistry of epoxies, and a demonstration of some of the properties and applications of the resins. The tests were particularly pointed to anti-corrosive and protective coating uses, and included such experiments as pouring a corrosive fluid over foil which was coated on the reverse side with epoxy resin. Here, the fluid ate through the foil, but did not affect the thin epoxy film. Tubes coated with epoxies were crushed and straightened without cracking the coating. A number of examples of potting electrical elements in epoxies were also shown.

Buffalo Section Hears Stannet

Approximately 50 members and guests attended the April 15 meeting of SPE's Buffalo Section at the Park Lane Restaurant, Buffalo, N. Y. T. V. Stannet, College of Forestry, State University of New York, addressed the group on the topic of "Plastic-Paper Combinations," pointing out that either material may serve as the additive.

Plastics are added to paper to impart such properties as flexibility, heat and pressure sealability, chemical resistance, protection of printing, scuff resistance, electrical insulation, structural strength, avoidance of fiber contamination, and resistance to gas and water vapor. Over 20-million pounds of urea resin were added to paper in 1954 in percentages of 0.5-3%. Polyester addition cuts the pressures required for continuous run laminations, and 12% of all polyethylene production goes into paper. It is thought that non-toxic resins will replace wax as a coating for milk cartons.

Paper filled with elastomers is being made on standard paper machines to form shoe innersoles and masking-tape backings. These papers have greater wet strength, good sizing properties, longer life, and, of course, better elongation.

Western New England Section Hears Maintenance Discussion

A six-member panel discussion on the techniques of plastics machinery repair and maintenance highlighted the technical session of the April 6 meeting of the Western New England Section, SPE, at Bradley Field's Terrace Dining Room, Windsor Locks, Conn. Eighty members were in attendance. John F. Krach, Rogers Plastic Corp., was technical chairman of the session.

Panel members and their topics included Rockwell B. Ward, Parsons Diamond Products, Inc., "Resurfacing of Molds"; Paul L. Holmberg, Arrow Hart & Hegeman Co., "Maintenance of Production Equipment and Materials"; Max Bizon, Rogers Plastic Corp., "Production of Injection Equipment and Materials"; T. J. Sheedy, T. J. Sheedy Precision Welding Co., "Arc Welding of Molds"; William Birmingham, C. F. Church Co., "Welding of Equipment"; and Albert F. Gagnon, Florence Tool & Die Co., "Mold Repair in the Shop."

Diamond compounds are becoming an important part of the plastics industry as tougher and harder steels are developed for molds, Mr. Ward said, particularly as economical polishes and abrasives in precision and step-grinding techniques. Plastic molds made in this fashion now are up to a production level of $50,000,000 annually, he asserted.

Mr. Holmberg covered special maintenance problems on heavy molding equipment. Describing a typical example of ram corrosion in which tightening of the bushing had caused scoring of the ram, he said that an experimental spraying of the ram with stainless steel proved to be a successful solution to the problem. The technique of using nylon bushings to prevent scoring in line valves was also discussed.

One of the big problems in molding is inadequate tolerances in initial mold construction, according to Mr. Bizon. Such faulty tolerances can cause overweight shots which considerably boost production costs of large runs. Close tolerances are especially important now since molders are manufacturing strong parts with half of the wall thickness formerly required, he said. Another vexing problem in the industry was the failure of moldmakers to inform the molder of repairs and corrections as the mold is being built, complicating later repairs and maintenance.

Mr. Sheedy outlined the technique of arc welding as applied to the mold making shop. He discussed the problems of porosity and gas generation during the welding operation, and suggested ways of minimizing these difficulties.

Explaining the many ways both torch and arc equipment can be used in maintenance work, Mr. Birmingham covered such processes as drawing and sweating of metals, bending, forming, cutting, brazing, silver soldering, closing off sprues of damaged cavity sections, prefabrication of jigs and fixtures, and the removal of platen and water channel plugs.

Mr. Gagnon gave his view of the essential difficulties involved in estimating repair costs for used molds built in another shop. Insufficient information reported on the nature of the mold metal and the history of its use complicates the repairman's problems. There are two sides to the question of where a mold repairer's responsibility begins and ends on a job, he pointed out, but full information submitted with a mold to be repaired would always benefit both parties.

SPI West Coast Conference

The twelfth annual conference of SPI's Pacific Coast Section was held April 13-16 at the El Mirador Hotel, Palm Springs, Calif. Attended by 684 members, guests, and their wives, the meeting included technical sessions on thermosetting and thermoplastic resins and aircraft applications, a golf tournament at the Tamarisk Country Club, and a fashion show.

The aircraft sessions focused attention on sandwich construction and reinforced plastics used for missiles and structural applications. The latest developments in prestretched acrylic sheeting, polymethyl chloroacrylate sheeting (Gafite), and similar materials for aircraft glazing were reviewed by J. G. Stansbury, Swedlow Plastics Co.

Adnan Waly, Electronized Chemicals Corp., described the equipment used by his firm for low cost irradiation of plastic materials. Succeeding papers by Monsanto representatives reviewed the market outlooks for styrene molding materials and vinyl resins; the latter being expected to increase by approximately 40% in the next five years.

Considerable interest was created by R. B. Greene's paper on Plaskon nylon 8200, Barrett's nylon 6. The new material is expected to compete economically with less costly materials of lower strength in industrial and consumer applications. Techniques and conditions for extruding high-impact polystyrene sheet for use in vacuum forming were explained by W. J. Canavan, Bakelite Co.

Section and Chapter (Southern California) officers were elected as follows: Section chairman, K. R. Mergen, Crest Molded Products, Inc.; and Chapter president, A. C. Young, Allied Chemical & Dye Corp.

Cleveland-Akron Section Meets

SPE's Cleveland-Akron Section met May 9 at the Spanish Tavern in Brecksville, O., 50 members attending. Ernest P. Moslo, Moslo Machinery Co., addressed the group on "Runnerless Injection Molding and Some Problems of the Injection Machine Builder."

Mr. Moslo's talk was published in the *SPE Journal*, April 1955, and an abstract appeared in the May issue of PLASTICS TECHNOLOGY. Movie shorts on golf were shown following the technical session, as a prelude to the June Golf Outing.

Toledo Section Tours

A chartered bus conveyed 21 members of SPE's Toledo Section to Cleveland on April 22 for a tour of Lester-Phoenix, Inc., manufacturers of injection molding and die casting equipment. Other members joined the group in Cleveland for a dinner at Kiefer's Tavern prior to visiting the plant.

The conducted tour included demonstrations of design, construction, checking, and operation at the various manufacturing stages. Engineering and performance were discussed and illustrated with a series of projection slides showing flow control circuit, differential pressure and booster circuits, the hydraulic ejector system, the overload compensator, and the nylon cutoff attachment.

NY Reinforced Group Meets

Approximately 67 members attended the April 27 meeting of the Reinforced Group, SPE's New York Section, at McGinnis' Restaurant, Jamaica, N. Y. The technical session featured a talk by Maurice Martin, Bassons Industries Corp., on "Better Reinforced Plastics Through Quality Control," and the showing of a movie, "Abrasive Finishing of Reinforced Plastics," by J. R. O'Neill of Carborundum Co.

The problem, as presented by Mr. Martin, involves the setting-up of a reasonable set of standards by the reinforced plastics industry. The biggest difficulty is maintaining a uniform thickness within narrow tolerances, since reinforced plastics processing uses a variety of glass cloths and overlaps. This factor is compounded by the molds which also operate within tolerances. Mr. Martin closed by stating that production control must go hand-in-hand with inventory control. Production departments should keep a log book of the whole job, containing the bill of material, the operation sheet, and the inspection check list. Inventory should have at least four different colored tags labeled acceptance, withhold, rework, and reject.

The excellent color movie depicted the finishing of reinforced plastics parts, both large and small, with different types of machines and abrasives. Carborundum's recommendations are governed by the surface condition, the finish desired, whether it is to be a wet or dry operation, production quantities, and size and shape of the part. The company manufactures a number of metal cloth belts, resin sander discs, paper discs, sand screens, and cabinet paper for use with a variety of finishing tools such as backstands, platen machines, slack belts, jitterbugs, and grinders.

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NEWS of the INDUSTRY

Trends in Plastics Discussed

The twelve basic types of plastics were discussed in terms of compounds, their present and future demand, by Gordon Brown, Bakelite Co., New York, N. Y., in a talk before the Chemical Market Research Association, New York, N. Y., on May 19. Figures are based on competitive compounds having equivalent solids or resin content, and Mr. Brown compared production estimates for 1954 with those anticipated for 1960:

	Million pounds produced	
	1954	1960
Vinyls	950.2	2,676.1
Polystyrene	609	1,407.9
Polyethylene	210	627
Phenolics	400.9	521.7
Urea & melamine	236	340
Cellulosics	120	144
Acrylics	60	80
Polyesters	26	60.2
Epoxies	22.8	82
Polyamides	15	45
Alkyds	6	6
Fluorocarbons	1.5	6
Totals	2,657.4	5,995.9

An analysis of these figures productwise shows, in the case of vinyl compounds, a high percentage of the production going into polyvinyl acetates for the paint industry. It was further estimated that the vinyl market cannot become saturated within the next few years.

The polystyrene demand also hinges on the expanding coating resin field, and the increase here will be largely modified rather than straight styrene due to the latter's lack of impact strength.

Polyethylene is expected to show its gains through the new low-pressure polyethylenes which are being developed. New products and new applications will be possible, largely due to the improved properties of the new materials. Additional growth is expected through films, coated papers, and the up-grading of wax.

An older resin like phenolic can be expected to become outmoded in certain applications; however, reinforced phenolics, syntactic foams, foundry, and shell molding resins should more than take up the slack.

Since Bakelite is not too active in the melamine and urea fields, these figures are based primarily on Barrett and Cyanamid estimates. They indicate that ureas should increase about 30% and melamine double in output. The latter gain will be due to tableware applications, restaurants having filled only 16% of their potential.

Cellulosic figures are based on the Tariff Commission report and estimates by Eastman Chemical. The improvement will be primarily dependent on butyrate in established household uses.

Acrylics can expect increased demands largely through the vacuum forming process of producing signs, skylights, and luminous ceilings, although Rohm & Haas expects a 50% greater demand for molding powder.

Polyesters have not yet lived up to their potential in spite of their strength-weight ratios. Automobile and truck bodies are expected to account for the greatest proportion of the increase.

Epoxies largely depend on surface coating and adhesive applications. In spite of their relatively high price, certain other characteristics of these materials, such as chemical resistance and fire retardant properties, may make this estimate far too conservative.

Polyamides have just been discovered as components of mechanical parts, and their increased demand should lie in this direction.

Alkyd molding materials had been expected to outmode phenolics for many applications due to their rapid molding and better resistance to carbonization under electrical arcs. In spite of their having been on the market for 10-12 years, they have not lived up to expectations and should show only a moderate growth, according to Mr. Brown.

In spite of their unusual properties, fluorocarbons are still too high priced to compete where their vastly superior properties are absolutely required. This is the opinion reflected by the sales department, not the production departments which estimate figures far in excess of those quoted.

The plastics laboratory at Naugatuck Chemical Division, U. S. Rubber Co., Naugatuck, Conn., is explained to a group of high school science students during Chemical Progress Week, May 16-21.

Plymouth's one-piece plastic headliner as used in the 1955 Suburban station wagon

Plastic Headliner Proves Worth

The one-piece plastic headlining which was installed for the first time in the 1955 Plymouth Suburban station wagon has reportedly proved superior over the old-style cloth liner owing to its ease of cleaning, insulating qualities, tear resistance, ease of removal, and the greater head room it affords.

Weighing just under 10 pounds, the liner is a high-impact rubber-resin alloy thermoplastic. The mold for the liner was improvised by cutting the top off a Suburban at the belt line, filling it with plaster, and smoothing it down to the proper shape and contour. A plastic male mold was poured onto this base, and in turn was used to cast the female mold into which styling and color were incorporated.

Insular Formed To Make PVC

Rubber Corp. of America, Hicksville, N. Y., and Ross & Roberts Co., Stratford, Conn., both producers of vinyl film and sheeting, have formed a separate corporation for the production of PVC resin. The new firm will be known as Insular Chemical Corp., and construction of a plant at Hicksville, N. Y., has already begun.

This move represents a departure from the status quo, in that two established consumers have joined to secure a basic and integrated position with respect to their chief raw materials. Heretofore, PVC manufacture has been exclusively in the hands of larger chemical companies.

The two companies will absorb the major output of this multi-million pound resin plant, and Rubber Corp. of America will also act as exclusive sales agents for the overstock, in addition to selling its own line of PVC plasticizers. A three-year engineering and development program preceded plant construction, and has reportedly resulted in the discovery of several new vinyl resins which may be offered on the market for special applications.

The new plant will be a model of automatic control and materials handling, according to current reports, and will incorporate the latest innovations in engineering design. Production should be under way by the spring of 1956, with existing laboratory and pilot plant facilities operating at an augmented rate. Calendering grade resins are already available in semi-commercial quantities.

Calls for Technical Leaders

The need for leadership in the field of technology was stressed by Henry B. du Pont, vice president of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., in addressing the May 9 dinner meeting of engineering professors who were touring the facilities. National progress depends upon production technology, he added, and technology can advance only in an environment conducive to its growth.

In this respect, technology needs spokesmen, men and women who can win public understanding and acceptance for scientific advances. This could help overcome the fear that automation, a technological development, destroys jobs and undermines the status of the worker in society. Short-sighted teachings breed misunderstandings which result in distrust, a factor which hinders progress more effectively than economic disasters.

Leadership is not an easy role, Mr. Du Pont stated. It requires understanding of social problems beyond the scope of specialization. The engineering profession bears the responsibility for promoting confidence and understanding.

Offers Epoxy Casting Service

An epoxy casting service and supply, offering both potting embedment and encapsulation, has been announced by Liquid Casting Systems Co., West New York, N. J. Typical jobs include total encapsulation of capacitors in lieu of the customary plastic and ceramic covers; coil embedment in highly silica filled epoxy compounds; and total embedment of components.

The company has reportedly developed inexpensive multiple molds which are easily loaded with pig-tailed inserts. Sample or production runs can be handled at either the New Jersey plant or the customer's facility, and Liquid Castings adapts its equipment to the type of automation employed.

Goodrich Radiation Chamber

A five-ton cobalt-60 radiation chamber will soon be installed at The B. F. Goodrich Company Research Center, Brecksville, O., for rubber and plastics research, according to F. K. Schoenfeld, Goodrich vice president in charge of research.

The chamber, known as a "pig," has 10 inches of lead shielding, and is said to be the first such facility existing outside of government atomic laboratories. It was designed by the company's nuclear study team, headed by R. G. Bauman, in conjunction with the Brookhaven National Laboratory and the Walter Kidde Laboratories, and constructed by National Lead Co.

The device will be loaded with flat slabs of cobalt-60 at Brookhaven before shipment to Brecksville. Materials placed within the chamber will not be made radioactive.

Spencer Chemical's polyethylene plant at Orange, Tex., partly visible behind administration building

Spencer Opens Poly-Eth Plant

A multi-million dollar Orange, Tex., polyethylene plant was opened by Spencer Chemical Co., Kansas City, Mo., with dedication ceremonies on May 16, the first day of Chemical Progress Week. The new facility was opened just 21 months after ground-breaking, and is designed to produce 45 million pounds of Poly-Eth polyethylene resin a year.

Start-up was announced February 22, following a highly successful test run. The plant was placed on automatic control within 15 minutes after initial production, which is considered unusual in view of the complex mechanical processes involved. The material is produced from ethylene gas, which is supplied to the Orange works by pipeline from Gulf Oil Corp's refinery in Port Arthur, Tex. Processing requires the exertion of pressures in excess of 15,000 psi. to compress the gas into workable polyethylene.

Phillips To Erect Laboratory

Phillips Petroleum Co. has authorized the construction of a chemical research laboratory near their Bartlesville, Okla., headquarters. A several-million-dollar addition to the Phillips Research Center, the new unit is expected to make Phillips' research facilities one of the most modern in the chemical industry.

Recent research developments have produced such petrochemical developments as oil furnace carbon black, improved synthetic rubber, and, most recently, Marlex polyethylene.

Lectures in Colloid Science

A special two-week lecture series in "Colloid Science" for researchers, teachers, and industrial executives will be given during the forthcoming summer session at the Massachusetts Institute of Technology, Cambridge, Mass., July 11-22.

Lecture topics will include the historical development of colloid science, the colloidal state, the production of colloidal systems, kinetics of colloidal particles, electrical properties of colloidal systems, surface phenomena, protection and sensitization, dispersion, coagulation and dissolution, the optics of colloidal systems, and industrial applications in such fields as rubber, plastics, food technology, and medicine.

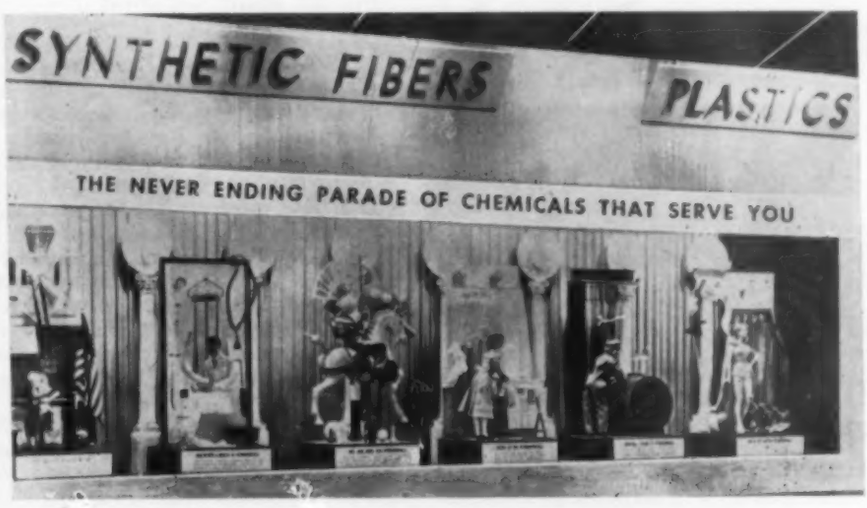
Ernst A. Hauser, professor of colloid science at MIT, will direct the program. Guest lecturers include D. S. le Beau, Midwest Rubber Reclaiming Co.; Eugene Rochow, Harvard University; D. L. Shanklin, Dewey & Almy Chemical Co.; A. G. H. Dietz, MIT, and Alan S. Michaels, MIT.

Registrants may reserve rooms in the Institute's dormitories, and all recreational facilities will be made available. Application blanks may be obtained from the Summer Session Office, Room 7-103, Massachusetts Institute of Technology, Cambridge 39, Mass.

Chemical Industry Exhibits At How-to-Invest Show

Chemistry's contribution to American life was dramatized in the Manufacturing Chemists' Association exhibit at the How-to-Invest Show, which was held May 24-30 at the 71st Infantry Regiment Armory, New York, N. Y. Plastics and synthetic fibers were among the featured products.

Sponsored by Merrill, Lynch, Pierce, Fenner & Beane, securities brokers, the show was designed to answer frequently asked questions about the American economy and the stock market. Companies and associations in eight leading industries were represented. The chemical industry was depicted in a series of panels, each about 10 feet wide and eight feet high, occupying a 70-foot booth.



Portion of chemical industry exhibit at How-to-Invest show

Plastics Fair Widens Scope

New exhibits in the fields of motion pictures, packaging, glass-fibre plumbing, machinery, electronic heating equipment, and foamed plastics have been scheduled for the World Plastics Fair and Trade Exposition, to be held in Los Angeles, Calif., October 5-9.

An aeronautical advisory board has been formed to plan a major exhibit of radome applications, canopies, duct systems, targets, and other plastic utilizations throughout the aircraft industry. The Exposition is designed to appeal to all segments of Western industry, users of plastics and non-users alike. The exhibits are open to the public evenings and during the final two days.

Hercules Opens Higgins Plant

A multi-million-dollar oxychemical plant has been opened by Hercules Powder Co., in Gibbstown, N. J. Designated the "Higgins Plant" in honor of former president C. A. Higgins, it marks the entrance of Hercules into new fields of chemical processing.

The new facility is designed to produce 26 million pounds of phenol annually, as well as alpha-methylstyrene, acetophenone, and hydroperoxides. Hercules employs the cumene oxidation process, a development of 15 years of research. The company has also acquired U. S. patents on an equivalent process which was developed independently by Distillers Co., Ltd., England.

Petroleum refineries and steel mills are a prime source of benzene and propylene, the raw materials used for phenol production. The new plant is expected to become the largest producer of synthetic phenol on the Eastern Seaboard region which consumes nearly half of the entire national production.

The plant occupies a 300-acre site to allow for future expansion. Para-cresol, which is now being produced at the company's Hattiesburg, Miss., plant, will be produced in quantity at Gibbstown. The Higgins Plant was constructed by M. W. Kellogg Co. and the Walsh Construction Co. It employs approximately 90 people.

View of Hercules' new oxychemical plant at Gibbstown, N. J., showing the cumene return still and the alkylation area

Stresses Material Selection

In a speech before the National Aeronautical Electronics Conference on May 10, J. H. DuBois, vice president of Synthetic Mica Corp. and Mycalex Corp. of America, Clifton, N. J., emphasized that there is a sufficiently wide range of plastic and ceramic materials for almost any product engineering job; the problem involves making the wisest choice.

The majority of failures in plastics product design, he continued, result from insufficient knowledge of operating conditions and material limitations. Examples of this type would be the choice of a material with inadequate impact strength, arc resistance, or dimensional stability, and excessively close tolerance requirements.

No one material will have all plus qualities with no minus considerations; therefore, economical production hinges entirely upon material selection. The cost factor is actually negligible, since the wrong material is always the most costly, Mr. DuBois said.

Monsanto Increases School Aid

Fifty-three American colleges and universities will benefit from 72 direct-aid awards under an expanded program of financial aid to scientific education launched by Monsanto Chemical Co., St. Louis, Mo. This represents an increase of nine schools and 15 awards over the company's 1954-1955 program.

Awards for the coming school year include 16 fellowships, 31 undergraduate scholarships, and 25 cash grants. Fellowships for graduate study average $3,000, while scholarships cover tuition costs and are awarded by the schools on the basis of merit and need. The cash grants are used at the school's discretion to finance research and purchase equipment.

In addition to the direct-aid awards, Monsanto issues grants through faculty and student trainee programs, and to other educational projects sponsored by societies and institutes.

Finishes Plant Opened

May 14 marked the formal opening of the Raffi & Swanson, Inc., new million-dollar plant at 100 Eames St., Wilmington, Mass., a site chosen for its convenience as a distributing point. The 14-building layout occupies a 15-acre site, and reflects the experience gained in 30 years of product engineering, materials handling, packaging, and shipping.

The new unit has already initiated production of spray lacquers for styrene and acetate moldings and sheet stock; gravure inks for vinyl sheeting; base- and top-coats for vacuum metalizing; and cements for assembling styrene, acetate, and nitrate articles.

Raffi & Swanson acquired Monsanto's surface coating department in 1951, having been in the industrial coating field since the early twenties.

E. H. Johnson

E. H. Johnson Joins PT Editorial Advisory Board

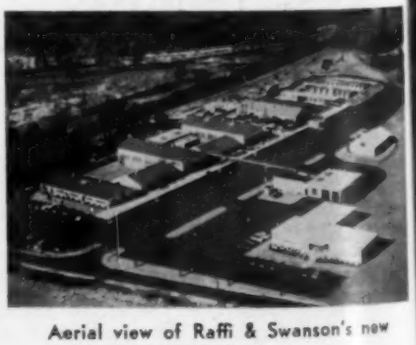
With this issue, E. H. Johnson, executive engineer and manager of mills and calenders sales for Farrel-Birmingham Co., Ansonia, Conn., joins the Editorial Advisory Board of PLASTICS TECHNOLOGY. Mr. Johnson fills the vacancy on the Board left by the accidental death of N. J. Elder (see our May issue, page 247).

A native of Connecticut, Mr. Johnson is a veteran of 39 years of service with Farrel-Birmingham, joining the company in 1915 as a draftsman after attending Northeastern College and Yale University. He was a designer from 1920-1928; chief draftsman of the rubber division from 1928-1933; divisional engineer on rubber and plastics from 1933-1943; sales manager of rubber and plastics machinery from 1943-1946; and has held his present position since 1946.

Mr. Johnson is the originator of the Z-type calender for rubber and plastics, and did much of the original work in the development of the triangular three-roll calender, the high-speed tilted reclaim refiner, and flooring processes. A professional engineer in Connecticut, Mr. Johnson is a member of SPE, SPI, the New York Rubber Group, and various fraternal and other associations.

Cadet Constructs New Plant

A $400,000 plant, consisting of 10 buildings and covering approximately 25 acres of a 300-acre site in Burt, N. Y., will serve as the new headquarters of Cadet Chemical Corp., Buffalo, N. Y. Slated for occupancy on or about June 1, the facility was especially designed for production of the company's organic peroxide catalysts, benzoyl, lauroyl, and methyl ketone. The chemical division of McKesson & Robbins, Inc., serves as exclusive sales agent.



Aerial view of Raffi & Swanson's new headquarters and plant

Sells Molding Press Business

Standard Machinery Co., Mystic, Conn., has announced the completed sale of its molding press business to Hull-Standard Corp., Abington, Pa., a newly-formed and completely separate company. Acceptance by industry of Standard's plastics extruding and electrical wire insulating machinery has forced expansion to the point where plant facilities were entirely inadequate for both types of production.

Hull-Standard Corp. was organized specifically to continue the manufacture and sale of Standard presses. Terms of the sale were not disclosed; however, the line will be continued intact under the Standard trade name, and engineering assistance will be supplied by Standard Machinery for a period of three years. The line currently consists of compression and transfer presses in six capacities from 50-300 tons.

Mastic Tile Buys Wright Mfg.

Mastic Tile Corp. of America, New York, N. Y., has purchased Wright Mfg. Co., Houston, Tex., said to be the oldest existing manufacturer of rubber tile and flexible vinyl tile flooring. The acquisition is reported to add $12,000,000 to the annual sales volume of Mastic Tile, making it the world's largest producer of resilient tile flooring and wall products.

Wright's assets include its 125,000-square-foot Houston plant which employs 200. Its products will continue to be distributed under its own trade name, and the company will operate as a division of Mastic Tile. President of Mastic Tile is Harry A. Hachmeister.

Ekco Acquires Shel-Glo Line

Ekco Products Co., Chicago, Ill., has purchased the plastics housewares division of Kilgore, Inc., Westerville, O., for an undisclosed sum. The purchase includes equipment, supplies, and inventory of products marketed under the trade name "Shel-Glo." Kilgore's injection molding process is expected to round out Ekco's over-all plastic operations.

Thiokol Expands Facilities

Thiokol Chemical Corp., Trenton, N. J., has completed the installation of new equipment that will more than double the production capacity of its Plasticizers TP-90B and TP-95, low-temperature plasticizers for vinyl resins and various rubbers. Recent increased demand for these materials prompted the expansion, the company says.

The design of the stainless steel facilities is said to represent an engineering advance over former equipment, with lower volatility and better dielectric properties for the plasticizers expected to result.

Compares Abrasion Resistance

Metaseal Plastic Coating, a product of American Metaseal Corp., West New York, N. J., was compared with alkyd-based floor paints, chlorinated rubber finishes, and clear varnishes for abrasion resistance in a recent test by a leading paint manufacturer. The test measured abrasion loss per 100 revolutions of the Taber Abrader's grinding wheel (CS-10).

Reports indicate a life-span for the plastic coating twice that of alkyd and rubber paints, and three times that of varnish. In addition, the tests indicated that chlorinated rubber finishes fail by chipping and flaking before they fail by abrasion.

Celanese Doubles Plant Capacity

The productive capacity of Celanese Corp. of America's Pampa, Tex., plant will be doubled at around June 1, according to company sources. The unit produces vinyl acetate for use in water-based paints, PVA adhesives, and coatings for leather, paper, cloth, and films.

Facilities are also being installed at Pampa for the production of methyl ethyl ketone, a solvent used in surface coatings, lubricating oils, adhesives, film, and cleaning compounds.

Inserts for Golf Clubs

Thermosetting laminated plastics are being used as inserts for impact surfaces of golf clubs manufactured by Bailey & Izett, Ardmore, Pa. Grade LRF, a product of Synthane Corp., Oaks, Pa., was chosen for its resiliency, and its length- and cross-wise strength.

The laminate consists of a fabric base mat with long fibers distributed at random. This grade is said to be easy to machine for precision fitting and dimensionally stable, properties not found in the pressed cellulose fiber inserts formerly used.

Rigid Frame Swimming Pools

A new line of rigid frame swimming pools, rectangular in shape, has been introduced by Doughboy Industries, Inc., New Richmond, Wis. The pool liner consists of heavy canvas impregnated with Pliovic, vinyl resin, a product of Goodyear Tire & Rubber Co., Inc., Akron, O. The combination is said to provide a tough, pliable liner that is resistant to cracking, peeling, and abrasion.

Interlocking frames of light tubular steel obviate the need for nuts and bolts since the frame sections are slipped into hems in the liner and locked in place. Four snap-on seats are provided for attachment to the corners. The frames are finished in baked enamel.

Five models are available with capacities ranging from 70-430 gallons. All models come complete with repair kit, assembly instructions, and a die-cast aluminum shower attachable to any garden hose.

New Laboratory Annex of South Florida Test Service

Testing Firm Expanding

South Florida Test Service, Miami, Fla., has added a 3,000-square-foot laboratory annex to its current facilities and is building an adjacent 75,000-square-foot auxiliary test field. The firm specializes in weathering, corrosion, and sunlight tests on rubber, plastics, textile, protective coatings, paper, and other goods, for both private industry and governmental agencies. The year-round hot and sunny climatic conditions of Florida make for naturally accelerated deterioration tests, the company says.

Uses Koroseal Conveyor Belt

Installation of a Koroseal vinyl conveyor belt in a spray booth at Ford Motor Co.'s trim plant, Detroit, Mich., has also "trimmed" over-all maintenance operations by 30%, according to company sources. The belt is used to carry trim panels through the booth where they are sprayed with a rubber latex dispersion to bind the parts together.

Previously the rubber build-up on conventional belts was so rapid that it required shutting down the unit every four hours to install muslin protective belt sleeves, an operation requiring some 35 minutes. The smooth, non-porous surface of the Koroseal belts reportedly permits the latex to be stripped off at the end of each eight-hour shift.

A product of B. F. Goodrich Co., Industrial Products Division, Akron, O., the lightweight belts are said to be tough, flexible, and have excellent resistance to abrasion, oils, and most acids.

Koroseal Used in Minesweeper

Koroseal pipe and fittings have been used to some extent as a substitute for metal on the new U.S.S. Cormorant, a minesweeper, in order to diminish the ship's attraction for magnetic mines, according to Clyde O. DeLong, president of The B. F. Goodrich Company, Industrial Products Division, Akron, O., manufacturer of Koroseal.

The rigid plastic went into the making of pipes to handle bilge, cold salt water, and cold fresh water, as well as voice tubing and Diesel oil collector tanks and water tanks. Metals such as steel, copper, and cast iron were replaced, with considerable saving in weight. The 144-foot hull of the Cormorant is constructed of wood.

News from Abroad

To Make PVA Polymers

The Kunstharsfabriek Synthese N.V., Katwijk aan Zee, The Netherlands, is to produce polyvinyl acetate emulsions and copolymers for varnishes and finishes used in a number of industries, by an arrangement with Vinyl Products, Ltd., England, which will supply the necessary know-how. The Dutch company has for several years been operating under license of Reichhold Chemicals, Inc., so that it will now be in a position to greatly extend its activities.

Second Polyethylene Plant

A second plant for the production of polyethylene is reportedly to be constructed by Societe Ethylene-Plastique, in Lorraine, near Carling, France, from ethylene supplied by the local coking works. Three important French concerns hold joint interests in Ethylene Plastique: Houilleres du Bassin du Nord et du Pas-de-Calais, Paris (50%); Huiles, Goudrons et Derives, Paris (25%); and Societe Pechiney, Paris (25%). The company's first polyethylene factory at Mazingarbe started operating February 19, 1954. From that date to the end of October 1954, total output was 1,407 tons, of which 827 tons were produced in the last three months of the period.

Monsanto Plant Approved

Permission has been granted by the Argentine government for formation of Monsanto Argentina, S.A.I.C., a wholly-owned subsidiary of Monsanto Overseas, S.A., and for the construction of a polystyrene plant near Buenos Aires.

Design and engineering work for the plant has been completed, and it is expected to commence operations by early 1956. Monsanto will provide machinery, equipment and raw materials for the new operation, which will be directed by Stanley D. Allchin, president, and Enrique E. Krag, managing director.

Plastics in Brazil

Among the factors chiefly contributing to the rapid postwar development of the plastics industry in Brazil may be considered the favorable foreign currency position immediately after the war, and the generally accelerated pace of industrialization brought on by postwar optimism.

Brazil's first plastics factory, established in 1926, used casein plastics to produce small articles like toothbrush handles, buttons, knitting needles, etc., and a certain export business to other Latin American countries developed. When World War II ended, the large accumulation of foreign currency in Brazil permitted the importation into the country of large amounts of various plastic goods hitherto unknown here. These became so popular that a considerable demand continued even after the surplus foreign currency had been used up. At the same time, several Brazilian investors, infected by the pervading fever of industrial activity, threw themselves into the versatile field of plastics. Accessories for refrigerators, automobiles, radios, packing materials, rigid PVC tubes, and plastic-covered wood for various purposes were made. Bobbins of cellulose acetate, and smooth cloths impregnated with solutions of urea-formaldehyde, are credited with contributing considerably to the modernization of Brazil's textile industry.

Of the plastics most in demand before 1949, the country produced only phenolics cellulose acetate and a small amount of urea-formaldehyde. Vinyls and polystyrene had to be imported. Unfortunately, greatly increased demand coincided with the exhaustion by 1948 of reserves of foreign currency. Since the authorities at the time had a false idea of the usefulness of plastics, imports of raw materials and machinery for working them, obtained mainly from the dollar area, were subjected to licensing, and the young industry suffered accordingly.

In 1949, Germany resumed trade with Brazil, supplying styrene monomer and others. The establishment of the first polystyrene plant in Brazil helped to open the eyes of the authorities to the real importance of plastics. By this time, 850,000,000 cruzeiros had been invested, and so the government was now more favorably inclined to the importation of plastics machinery and basic materials. This new attitude encouraged Koppers to set up the second Brazilian polystyrene plant. By 1952, the two modern plants together were capable of processing a total of 6,000 tons of styrene monomer annually. Today, Brazil claims to produce a material that is second to none.

Besides polystyrene, Brazil now makes phenolics, urea-formaldehyde, and acetate cellulose. Consumption of these plastics is said to total 5,000 tons annually. Polyvinyl chloride was not hitherto produced here, but recently Geon do Brasil erected a plant in Sao Paulo. This plant has an initial monthly capacity of 225 tons, and the output can be doubled. There are three large converters of PVC and at least two smaller ones. Both rigid and flexible vinyl sheet, tubing of all kinds, and insulations for the electrical industry are produced, with the annual output estimated at 5,000 tons.

Incidentally, the rapid growth of the plastics industry in Brazil has created a very important market for the by-products of petroleum. This should be of mutual benefit to the plastics production and petroleum refining industries.

Printing PVC Fabric and Film

A French and a Dutch method of printing PVC surfaces have been announced almost simultaneously. In France, Etablissements Blondel-La Rougere have succeeded in making maritime and aerial charts, and military and road maps and plans from Retrovyl (a fabric woven from Rhovyl PVC fiber), printed by a patented "Resi-Color" process adapted from the offset printing method. These maps, besides being very clear, are claimed to be about 30% lighter than the usual paper maps mounted on cloth. In addition, they are non-inflammable and practically untearable; impervious to water and snow; resistant to temperatures ranging from —80 to +80° C.; and are not attacked by rodents, parasites, acids or grease.

In Holland, the "Opticolor" process has been developed by Octrooitex C.V., Enschede, in collaboration with a textile printing firm. All kinds of reproductions on PVC films and sheets in black and white as well as in all colors can be made. A photochemical process is employed in which the pigments unite with the material to which they are applied, resulting in considerable resistance to wear, water and many chemicals. There is claimed to be no limit to the color gradations possible so that half-tone sections of pictures are easily reproduced. The suggested uses are: dust covers for expensive books or for such as undergo much handling, military and road maps, books for children, lamp shades, window-posters, etc.

Polystyrene in Australia

The first stage of polystyrene production has been completed at the new up-to-date Rhodes plant of C.S.R. Chemicals. General purpose polystyrene molding powders, under the trade name of Starex, are now available in the form of crystal clear and colored pellets, and as colorant blend.

At the same time, Walter Barr Pty., Ltd. (a division of International Products Ltd.) announces that it is producing high impact polystyrene sheet at its factory in Enfield, New South Wales. Sold under the name of Barrene, the sheet is made in two finishes, high gloss or smooth on one side and mat on the other, and in a standard white color, but other colors can be supplied to special order. This new venture will make it possible for the Australian industry to use freely a material hitherto practically unobtainable there because of dollar restrictions on importation.

NAMES in the NEWS

William J. Roberts

William J. Roberts has been advanced to director of research of Pennsylvania Industrial Chemical Corp., Clairton, Pa., replacing **A. L. Ward,** who has retired. Nicholas C. Gangeni is now assistant director of research.

William R. Haas has been appointed a director of sales for the overseas division of Monsanto Chemical Co., St. Louis, Mo. He previously served as resident European supervisor of Monsanto Overseas, S. A., with offices in Paris. **Julio J. Usera,** New York district sales manager for the overseas division, replaces **Mr. Haas. Kenneth R. Stelloh,** merchandising and resale products manager, succeeds **Mr. Usera.**

M. J. Ross has been appointed export trade manager for both Quaker Rubber Corp. and Watson-Stillman Co., divisions of H. K. Porter Co., Inc., New York, N. Y.

Henry R. Lasman has been put in charge of the new rubber and plastics laboratory of National Polychemicals, Inc., Wilmington, Mass.

John S. Brice has joined the chemical division of the Goodyear Tire & Rubber Co., Akron, O., as field representative in the Southeastern sales territory, with headquarters in Atlanta, Ga.

Raymond L. Cassell has been promoted to divisional chief plant engineer for the organic chemicals division of American Cyanamid Co., New York, N. Y.

M. W. Duncan and **J. R. Retter** have been named assistant sales managers for Carbide & Carbon Chemicals Co., New York, N. Y. They will serve the Kansas City and Detroit districts, respectively.

Joseph D. Robertson has been appointed sales representative for Watson-Stillman Co., division of H. K. Porter Co., Inc., Roselle, N. J. His territory will include North and South Carolina, Georgia, and parts of Florida.

Elerington Saunders and **Reginald N. Gonzalez,** chemical engineer and research chemist, respectively, at Monsanto Chemical Co., Springfield, Mass., have been granted a year's leave of absence with pay to do advanced study.

Howard R. Huston has retired as vice president and director of American Cyanamid Co., New York, N. Y., after 25 years of service. He will maintain association with the company on a consulting basis.

Robert F. Elder

Robert F. Elder has been elected executive vice president of Plax Corp., Hartford, Conn. For the past five years he has been a marketing consultant, prior to which he served as vice president in charge of Lever Brothers' affiliated companies. **Robert A. Glaenzer,** formerly general sales manager, becomes vice president in charge of sales. Former research director, **C. Paul Fortner,** was named vice president in charge of research and development. **Richard S. Light** has joined Plax as general factory manager. He formerly served as vice president in charge of procurement and production for the Snow Crop Division, Clinton Foods, Inc.

Albert Koper, formerly Akron, O., technical sales representative for Harwick Standard Chemical Co., has been named resident manager of the firm's new office and warehouse in Albertville, Ala., which will serve the Tennessee, Alabama, Mississippi, Western Georgia, and Louisiana sales territories.

Robert D. Scott

Robert D. Scott, general manager of plants for B. F. Goodrich Chemical Co., Cleveland, O., has been named vice president of manufacturing. Joining the company in 1935, Mr. Scott became technical superintendent of the firm's Akron, O., chemical plant in 1940; plant manager of the Niagara Falls, N. Y., Geon plant in 1941; manager of the Louisville, Ky., Geon plant a year later; and general manager of plants in 1951.

Oliver P. Stroup has joined Acheson Dispersed Pigments Co., Philadelphia, Pa., as an applied research chemist. He formerly served with Ciba Co., and the General Chemical division of Allied Chemical & Dye Corp.

Robert J. Koll has been named plant manager of the Greens Bayou plant of Diamond Alkali Co. at Houston, Tex., replacing **Henry S. Curtis,** who has resigned. Associated with the company since 1945, **Mr. Koll** was previously a development engineer with Rohm & Haas Co. and B. F. Goodrich Chemical Co.

Eli Jensen has resigned as an officer and director of Cambridge-Panelyte Molded Plastics Co., division of St. Regis Paper Co., New York, N. Y., due to illness. **C. Russell Mahaney** becomes president of the Cambridge Co., and **David T. Culbertson,** vice president, in other organizational changes.

William E. Van Horne has been appointed assistant sales manager for Industrial Nucleonics Corp., Columbus, O. Prior to joining the firm as sales engineer, he served in the same capacity with the Brown Instrument Division, Minneapolis-Honeywell Regulator Co.

A. D. Winquist, Jr., and **Marcus French** have been transferred from the new products division of National Aniline Division, Allied Chemical & Dye Corp., New York, N. Y., to the chemical sales department of the company.

J. S. Stanford has been appointed vice president of Varcum Chemical Corp., Niagara Falls, N. Y. In addition to management activities, he will assume major responsibility for the company's expanded sales program.

Names in the News (Cont'd.)

George E. Holbrook, assistant director of the development department of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has been advanced to assistant general manager of the company's organic chemicals department, succeeding **Samuel Lenher,** who has been elected a director, vice president, and member of the company's executive committee.

Earl W. Loucks has joined Thiokol Chemical Corp., Trenton, N. J., as technical sales representative.

C. A. Stokes, director of research and development for Godfrey L. Cabot, Inc., Boston, Mass., has been elected to the board of directors of the Industrial Research Institute.

Robert A. Christman has been appointed chief chemist for Mobay Chemical Co.'s New Martinsville, W. Va., plant, where he will direct the activities of the control and analytical laboratories.

Albert B. Chesley has been appointed personnel superintendent for Mobay Chemical Co.'s new plant at New Martinsville, W. Va. He has been serving as personnel assistant at Monsanto's Queeny plant in St. Louis, Mo.

Howard F. Norman has been named product manager, industrial trades, in the adhesives and coatings division of Minnesota Mining & Mfg. Co., St. Paul, Minn., and **August J. Kochis** has been appointed government representative for the division.

Mark B. Stringfellow has been appointed manager of market development for Spencer Chemical Co., Kansas City, Mo. He previously served as manager of Nopco Chemical Co.'s plastics division, and with Carbide & Carbon Chemical Co.

Mark M. Wolff was made secretary of Adamson United Co., Akron, O. He joined the company as plant auditor, and has been serving as assistant treasurer.

Robert G. Werner has been elected vice president and general manager of Vulcanized Rubber & Plastics Co., New York, N. Y.

F. L. Dawes

F. L. Dawes, president and general manager of Adamson United Co., Akron, O., was elected to the board of directors of United Engineering & Foundry Co., Pittsburgh, Pa. The latter company is one of the world's largest producers of rolling mills and mill machinery.

George T. Barks has been named assistant sales manager for Monsanto Chemical Co.'s Opalon vinyl resins, with offices in Springfield, Mass. He has served as technical service representative for Opalon copolymers, and was responsible for their development as flooring materials and phonograph records.

Matthew G. O'Connor has been appointed West Coast district sales manager for Sylvania Division, American Viscose Corp., Philadelphia, Pa. He previously served as special representative for the company in the California area, and as sales manager for Modern Containers and Celanese's plastics division. **L. E. Nash** was named sales representative for converter accounts serviced by Sylvania on a direct basis. He has been performing this service in the Chicago area since 1950.

Edward C. Meisner has been appointed general manager of the Plymouth Meeting, Pa., plant of The Philip Carey Mfg. Co., Cincinnati, O. He was formerly general manager of Avco Mfg. Corp.'s Crosley Division.

Howard S. Nutting, director of the central research index of Dow Chemical Co., Midland, Mich., and an international authority on the systems of naming chemical compounds, was presented with the Austin M. Patterson Award of the American Chemical Society's Dayton Section at the group's biennial award dinner at Antioch College, Yellow Springs, O., May 14.

Roland Voorhees has been appointed associate director of development for the chemicals and plastics division of Union Carbide & Carbon Corp., New York, N. Y. Formerly the assistant director of engineering for Carbide & Carbon Chemicals Co., he will devote a major portion of his time to maintaining technical contacts with the European chemical industry's new syntheses and production processes.

Gerald Reinsmith has been named acting chief of the research branch, research and development division, Ordnance Weapons Command Headquarters, Rock Island, Ill. He was formerly factory manager for Narmco Metlbond Co., Chino, Calif.

Edwin H. Ahlefeld, Jr., has been promoted to assistant general sales manager of Farrel-Birmingham Co., Inc., Ansonia, Conn.

Frank J. Smith has been elected vice president and general sales manager, a director, and a member of the executive committee of Pan American Chemicals Corp., a newly formed subsidiary of American Oil Co., New York, N. Y. Formerly manager of American Oil's petrochemical division, **Mr. Smith** will direct the marketing of petrochemicals manufactured at the company's Texas City plant.

OBITUARY

J. Paul Smith

J. Paul Smith, 64, president of Visking Corp., Terre Haute, Ind., died suddenly on May 4 at a Chicago hospital. A native of Butler, Pa., Mr. Smith was graduated from Penn State University in 1912 as a chemical engineer.

Mr. Smith had been president of Visking for the past eight years, having previously served as executive vice president. Prior to joining the firm, he directed the development of cellophane in France for E. I. du Pont de Nemours & Co., Inc., and was instrumental in bringing the material to this country.

Mr. Smith is survived by his wife, Mrs. Elizabeth B. Smith.

Harry Hines Replogle

Harry Hines Replogle, 77, U.S. Dept. of Commerce, died in Washington, D. C., on March 7, following a brief illness. Born in Akron, O., Mr. Replogle served for many years in the rubber industry prior to joining Grasselli Chemical Co. and E. I. du Pont de Nemours & Co., Ltd.

In 1929 he helped organize the Sylvania Industrial Corp., serving as director, vice president, and sales manager. Upon retirement from active business in 1946, Mr. Replogle continued as director of Sylvania and, following its merger with American Viscose Corp., remained as consultant.

Mr. Replogle went to Washington in 1951 to serve the interests of the cellophane industry with the National Production Authority. At the time of his death, he was chief of the flexible packaging branch, containers and packaging division of the Business and Defense Services Administration.

He is survived by his wife, Mrs. Pearl B. Replogle, and two daughters.

New Materials

Polyethylene Packaging Film

A translucent polyethylene packaging film, which reportedly achieves good slip without loss of clarity and impact strength, has been introduced by Bakelite Co., New York, N. Y. Designated DXM-20, the film has a coefficient of friction of 0.20, which is significantly lower than regular polyethylene film.

Non-sticking film obviates the necessity of modifying the extrusion or film-handling processes. These operations were difficult to control and often resulted in loss of strength and clarity. The impact strength of a 1.9-mil film of DXM-20 is reported as 3.8 psi. Advantages are listed as follows: increased efficiency of extrusion operations; a wider range of operating conditions; faster through-put and more continuous operation; and the possibility of producing a quality controlled film.

Readers' Service Item M-1

Parting Agent for Bag Molding

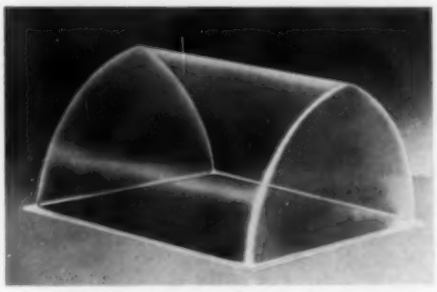
Some property data is now available on Lunn-Lease, a recently developed spray-type, film-forming parting agent for reinforced plastic bag molding processes. The material was developed by Lunn Laminates, Inc., to speed up production of bathtubs and reinforced plastic car body parts by the above mentioned process.

Reportedly consisting of seven components, Lunn-Lease's carrier evaporates when sprayed on the mold, leaving a uniform, non-tacky finish. Coatings as thin as one thousandth of an inch have been applied.

Mold surfaces should be cleaned with acetone and wax-polished before spraying the first coat of Lunn-Lease. About 15 minutes drying time should be allowed before applying the second coat. Two heavy flood-coats ordinarily suffice for non-porous surfaces; absorptive surfaces requiring 2-3 preliminary "dust" coats applied from a distance.

Standard spray equipment is recommended, using about 10 psi. pressure for the material feed and 45 psi. on the gun. With standard syphon cups, a pressure of 45 psi. is said to be adequate. The material does not require thinning; however, solvent loss by evaporation or aging may be overcome by the addition of pure acetone. Arrow Sales Co. markets the parting agent in five- and fifty-gallon drums.

Readers' Service Item M-2



Hot-Formed CO-4 Acrylic dome

Clear Cast Acrylic Sheets

Optically-clear cast rigid sheets of CO-4 Acrylic are being produced to tolerances of ±5 mils on ⅛-inch material by Cast Optics Co. The sheets are available in thicknesses ranging from 0.020-1 inch, and in four standard sizes; 36 by 48 inches, 48 by 48 inches, 36 by 60 inches, and 40 by 50 inches.

Reportedly characterized by ease of cutting, drilling, and machining, CO-4 Acrylic can be hot-formed to an unusual variety of shapes and designs. The acrylic monomer used in sheet casting is supplied both by Rohm & Haas Co., and by E. I. du Pont de Nemours & Co., Inc. Following are the physical properties attributed to the material:

Specific gravity	1.19
Refractive index @ 20° C.	1.49
Hardness, Knoop	18-20
Rockwell-"M"	85-105
Cold flow, Barcol Impressor	13
Abrasion resistance, Taber	1
Falling Emery	1
Tensile strength @ 25° C., psi	7,500
Flexural strength @ 50° C., psi	9,000-11,000
At 25° C.	13,000-15,000
At -57° C.	18,400
Modulus of elasticity in flexure, 50° C., psi x 10⁵	2.5-3.0
At -57° C.	4.8
Compressive strength, ultimate, psi	11,900
Modulus, psi. x 10⁵	3.1
Impact strength at 25° C., ft.-lbs./in.	
Izod, notched	0.5
Charpy, notched	0.5-0.55
Izod, unnotched	5
Charpy, unnotched	7

Readers' Service Item M-3

Glycol Ester Plasticizer

A glycol ester plasticizer said to exhibit superior low temperature behavior and resistance to extraction, has been introduced by Rubber Corp. of America. Designated BD-8 (butanediol dicaprylate), it is compatible with a wide variety of natural and synthetic rubbers and resins at low temperatures, a condition which reportedly permits increased extrusion speeds and smoother surfaces.

Absence of ether linkages is said to result in improved aging characteristics. Physical properties are reported as follows:

Specific gravity	0.929-0.932
Mid-boiling point @ 5mm. Hg., °C.	220
Distillation range @ 5mm. Hg., °C.	211-222
Flash point, °F.	390
Freezing point, °C.	10.5
Viscosity, cps.	19
Surface tension @ 25°C., dynes/cm.	33
Weight/gallon @ 20°C., lbs.	7.74
Solubility in water @ 25°C., %.	0.01
Water solubility in BD-8, at 25°C., %	0.16

Readers' Service Item M-4

Polymeric-Type Plasticizer

A high molecular weight, polymeric plasticizer with typically low volatility factor is being offered in commercial quantities by the Harchem Division, Wallace & Tiernan, Inc. Designated Harflex 300, the new plasticizer is said to provide lower temperature flexibility in vinyl formulations than any of the other true polymeric plasticizers.

Highly solvent, Harflex 300 incorporates readily in calendering or extruding, thus offering a shorter processing schedule. A light yellow, viscous liquid, it weighs approximately nine pounds per gallon and has a specific gravity of 1.088. Test formulas containing 100 parts Geon 101 vinyl resin; one part dibutyl tin dilaurate; and 50 parts of Harflex 300, dioctyl phthalate, and another competitive polymeric plasticizer were compared as to performance. Results are reported as follows:

	Harflex	DOP	Other P.P.
Hardness, Shore A	94	88	99
Elongation, %	380	360	330
Tensile strength, psi	3,250	2,930	3,140
Modulus, 100%	1,810	1,490	2,080
Extraction, 24 hrs. @ 50° C., %			
Water	1.0	0.1	0.3
1% soap	3.3	1.8	2.1
Mazola oil	2.8	7.6	1.5
Volatility at 212° F., loss after			
48 hours	0.7	0.7	0.5
70 hours	0.9	1.4	0.5
Stiffening temperature, °F.	60	45	70
Rigid temperature, °F.	10	-10	25
Heat stability @ 180° C.			
Hours to first discoloration	3.5	3.5	3.0
Hours to final discoloration	8.5	7.0	7.5
Weatherometer, 200 hours			
Spew	None	None	Severe
Discoloration	None	None	Severe
Lacquer attack, 30 days	None	Apprec'ble	Definite

Readers' Service Item M-5

IC Polyester Developments

Two new polyester resins and a fire-retardant for use with chlorinated polyester resins have been developed by the finishes division of Inter-Chemical Corp. The first resin is designated IC-671, and is a typical polyester made with vinyl toluene monomer instead of styrene. This offers the advantages of lower volatility, lower solubility, and improved flow properties in the mold. Specifications are reported as follows:

Viscosity, cps.	8,000-10,000
Specific gravity	1.147
Weight per gallon, lbs.	9.57
Heat distortion point, °C	85
Barcol Hardness	50-55

The resin's high boiling point gives it a rapid cure rate, a moderate exotherm peak, and good pot life. Suitable for premix compounds as well as press mold and potting applications, the resin's vinyl toluene content may be adjusted from its nominal 30% content, thereby changing the viscosity without materially affecting the strength properties. IC-671 responds to catalysts and activators, and can be used for hand lay-up applications with room-temperature cure.

IC-480 Thixogel Polyester is used both as an additive to polyesters for imparting thixotropy, and by itself for high or room temperature cures. It is also said to improve the flow properties of polyester premixes. The uncured resin is a thick paste consisting of approximately 25% styrene monomer and containing no inert pigments. One suggested formulation adds 10-20% IC-480 to IC-312 standard polyester to impart a decided thixotropic consistency.

IC-776 Antimony concentrate is a thick, butter-like paste which, when added to polyesters, imparts fire-resistance properties. This new paste form gives better dispersion than when added as a dry color. When used with IC-636 glass-reinforced polyester, the compound will have a surface flame spread in the range of 50 when run in the tunnel test according to Underwriters' specifications. It also meets General Electric's tepee test requirements. The compound has a weight per gallon of approximately 23.7 pounds, a specific gravity of 2.84, and is added to formulations in percentages of 5-7 by weight.

Readers' Service Item M-6

VANDERBILT
MATERIALS
For VINYLS

VANSTAY L

Recommended for Maximum Light Stability and Improved Natural Aging in All Vinyl Resin Compositions.

VANSTAY HT · VANSTAY S

This Combination Provides Excellent Heat Protection for Vinyl Compositions During Processing and in Service.

VANSTAY R

Clear Liquid Heat Stabilizer for Use in Vinyl Compositions.

VANCIDE 89

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Our Technical Service Representatives Will Gladly Demonstrate the Merits of Our Materials in Your Plant and Assist in Solving Production Problems.

R. T. VANDERBILT CO. INC.
230 Park Avenue, New York 17, N. Y.

Multi-Purpose Release Agent

Mold-Wiz, a high polymer mold release for both thermosetting and thermoplastic compounds, has been introduced commercially by Axel Plastics Research Laboratories. The material has gone through extensive field testing for the past two years, and has reportedly given instant, positive releases in all types of molding operations.

Non-toxic and non-staining, Mold-Wiz will neither explode nor corrode nor will it interfere with the plating or painting of castings. Properties are reported as follows:

Specific gravity	1.0
Density, lbs./gal.	8
Viscosity, cps.	25
Shelf life	Unlimited
Color, G.N.	Milky white
Flammability	Non-flammable

Mold-Wiz has been used in reinforced plastics molding; laminating and vacuum forming; and compression, injection, and shell molding. No special preparation is required, other than that the mold surface be clean and free from organic coatings and films. Available in one-, five-, and 55-gallon containers, the material can be sprayed, brushed, or wiped onto the mold. Mold-Wiz will also be marketed in a spray-bomb.

Readers' Service Item M-7

New Equipment

Three-roll Adamson Calender

Adamson Inclined Roll Calender

A new three-roll calender especially adapted for coating work has been announced by Adamson United Co. It is a 120-degree type in which the top roll is moved 60 degrees from the vertical plane. The tilt thus provided makes the top bank much easier to feed than it is in a conventional, vertical three-roll calender, and considerably reduces the effect of center roll deflection on the work being done in the bottom pass.

The calender is designed so that it may be equipped with a motorized crossed axis device for the offset roll, and conventional screw adjustment or hydraulic cells can be used on the bottom roll for applying pressure in the coating pass.

The new calender is available in the 24-by-64-inch size, equipped with either full-circle bronze or anti-friction bearings. Lubrication is by an automatic greasing system, but circulating oil lubrication units are available at extra cost.

The speed range of the unit may vary from 8 yards per minute for threading up to a maximum of about 75 ypm. The electrical drive has a normal rating of from 125-250 HP., and is an adjustable voltage type with infinitely variable stepless control. Friction ratios up to 3:1 are available, and larger ratios can be furnished using separate special drives for one or more rolls.

Readers' Service Item E-1

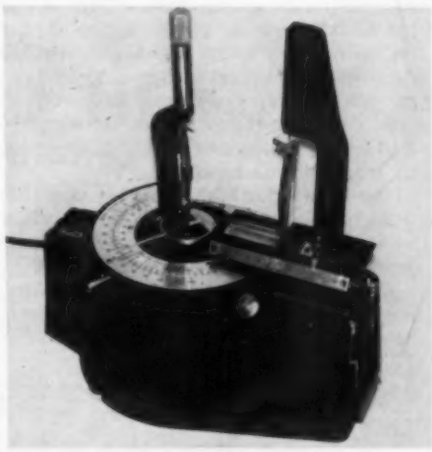
Universal Stiffness Tester

A testing machine capable of measuring stiffness and other related properties of such dissimilar materials as paper, cards, plastic sheets and films, coated fabrics, and leather, has been developed by United States Testing Co. Designated Carson-Worthington Universal Stiffness Tester, it is said to fill the need for a generally applicable tester capable of measuring not only material stiffness, but also the effects of coatings, treatments, and dimensional differences.

Interchange of torsion units is adjustable to different sample sizes and a wide range of stiffness values. Push-button controls operate the scales in either direction, and a circular level with three leveling screws is provided for accurate leveling. Data are recorded in gram-centimeters rather than relative units, thus permitting comparisons between test methods or between materials.

The 110-volt reversibly-geared motor operates on 60 cycles at two rpm., with dynamic braking. The 22-pound tester measures 13½ inches long by nine inches wide by 14 inches high at the center post. Self checking features coupled with excellent reproducibility make it useful for research, routine production, and quality control work.

The instrument's prototype was developed by V. Worthington and F. T. Carson of the National Bureau of Standards, and was first described in the Bureau's *Journal of Research*, December 1952.



U. S. Testing's Universal Stiffness Tester

Readers' Service Item E-2

NRM Model 55 Extruder

A new extruder which reportedly increases production of higher quality extrusions up to 50% has been introduced by the National Rubber Machinery Co. The machine is designated the NRM 2½" Electrically Heated Model 55 Plastics Ex-

You can be sure

you're planning your production properly if you've considered the advantages of

Marblette Plastic Tooling Resins

which can speed designs from drawing board to production run, require no heavy equipment investment or highly skilled labor, facilitate pilot runs and design changes, and

will save you up to 70% in time and up to 80% in cost

in making stretch dies, draw dies and panels, match dies, jigs, fixtures, patterns, models, prototypes, core boxes, plating shields, bag and contact molds, latex dip production forms, molds for fibrous glass lay-up, spray-metal backing, vacuum-forming, and electro-forming, and other types of tools and dies.

The versatile yet specialized liquid epoxy and phenolic resins developed by Marblette fit into your production picture. Convince yourself—see how they can give you increased economy and efficiency—use the handy coupon below for resin samples, technical data, a phenolic data folder, an epoxy data folder, and a conversion computer that shows at a glance how much resin to use for casting any size product or part.

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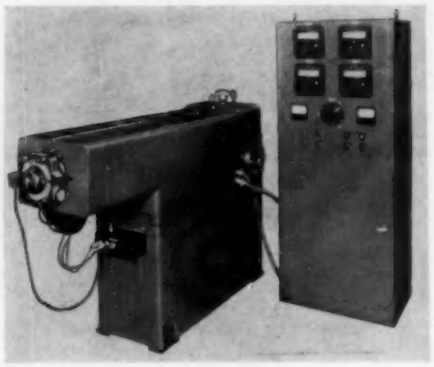


NRM Extruder and Control Cabinet

truder, and is intended for use with various thermoplastic compounds, including nylon.

Nominal rated capacity of the 2,800-pound machine is 120-125 pounds or approximately 2,800-3,400 cubic inches per hour. Full-flighted or other standard screws in chrome-plated alloy steel are available in 2½-inch diameters. A cast hopper section with a chrome-plated circular feed opening is centered over the screw and jacketed for water cooling.

A replaceable steel cylinder barrel, having a 2½-inch bore and a 20:1 Le/D ratio, is lined with Xaloy 306. Four heating zones, each with integrally cast electric heaters, are individually controlled by proportioning pyrometers having a temperature range of 0-800° F. Blowers and ducts are provided for balanced heat control.

The front end includes a full-diameter strainer plate and screens, removable for attachment of nylon dies and cross-head. Four swing-bolts are mounted to the standard die adapter gate for straight extrusion. The cylinder covers are insulated to prevent heat losses; total wattage capacity for cylinder and gate heating being 13.8 kws.

The extruder measures approximately 79¾ by 18 inches, and stands 53¼ inches high. The electrical control cabinet measures 19½ by 28 by 72 inches high, and location is optional. The enclosed housing contains a heavy-duty cone worm gear reduction unit (ratio 15:1), and automatically lubricated, oversize thrust and radial bearings. The extruder reportedly provides absolute control over frictional heat, requiring no extra air or water connections. A 15-hp. variable speed drive is recommended, arranged with sheaves and belts to provide screw speeds of 10-70 rpm.

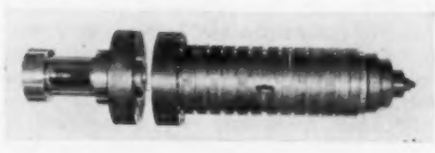
Readers' Service Item E-3

Interchangeable IMS Cylinder

The new IMS Extra Capacity Replacement Heating Cylinder represents a major step toward injection machine standardization in that it can be used interchangeably on the Reed-Prentice and HPM 16-ounce machines. Said to outperform the original heaters by 15-20%, the cylinder is virtually free of maintenance costs which, when they are required, reportedly run ⅓-½ less than standard equipment repairs.

The cylinder measures 37 inches overall, including a ¾-inch radius nozzle. An intermediate diameter of 9¼ inches permits a proper internal ratio of heating area to plunger area, using a 3-3¼ inch injection plunger. The wattage utilized is approximately 35,000, more than was used on a 60-ounce machine under the old cylinder ratings.

The rear flange of the heater has a 13⅜-inch diameter, and is equipped with heater bands to ensure better performance. Designed for maximum plasticizing capacity with minimum watt density on internally heated areas, the interchange unit reportedly permits molding at faster cycles without degrading, scale, or other evidences of overheating. The cylinder is fastened directly to the HPM type machine, or fitted to the Reed-Prentice by means of a special adaptor shown in the accompanying illustration.



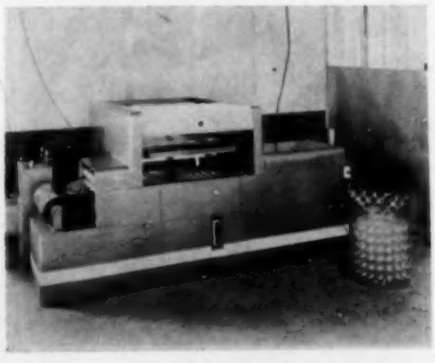
IMS Replacement unit and R-P adaptor

Readers' Service Item E-4

Automatic Vacuum Former

What is said to be the first fully-automatic, roll-feed drape and vacuum forming machine has been introduced by the Auto-Vac Co. Known as the Roll-Vac-22, the unit opens the way to continuous forming of transparent packagings and food containers, plus a wide range of high-volume parts. Cutting equipment can be synchronized in the line, as can be filling, covering, and trimming machines.

The 3,500-pound machine is approximately 120 inches long by 66 inches wide, and stands 60 inches at its highest point. Standard 22-inch plastic rolls are mounted at one end and the formed parts are continuously ejected from the opposite end. The standard forming area inside the clamp frame measures 20 by 30 inches, but can be adjusted to a minimum of 144 square inches by using a minimum roll width of 12 inches.



Auto-Vac's Roll-Vac-22 fully-automatic, roll-feed vacuum forming machine

The completely adjustable clamp frame consists of solid steel with sliding bars at both top and bottom. All moving parts are interlocked by microswitches so that the heater cannot move forward if the clamping frame is open, and the drape frame cannot be raised if the heater is forward or if the vacuum valve is open. Drape is incorporated into the forming operation with adjustable down-and-up stroke speed. Stroke can be set from 0-4 inches, with additional height requirements to specification. Drape power drive is operated by a single air cylinder with synchronized twin toggle action.

The automatic feed mechanism is adjustable to handle 12-32 inch sheet lengths. Rolls up to 15 inches in diameter are accommodated, and the machine itself is equipped with three- or six-inch core adaptors. The 26- by 36-inch heating area is wired for 220/440 volts, 3-phase, 60-cycle, or to specification. Radiant-type heating elements are balanced electrically to provide outer-edge heating.

The vacuum system operates on ¾-hp., 14-cfm., to provide 28 inches of operating vacuum. Pump and motor are integrally mounted and muffled, and a lined, 100-gallon steel reservoir tank is built directly into the machine.

The dead-front wiring box contains the main power switch, the main contractor, the heater fuse unit and the transformer. The machine can be set for manual as well as automatic operation, and is timed for heating and cooling cycles by two-minute Eagle Signal timers calibrated to 1/10-second intervals. Air pressure is set for 85-100 psi., less than 12 cfm. The air blow-off is automatically cycled, with adjustment for controlling intensity and length of blast.

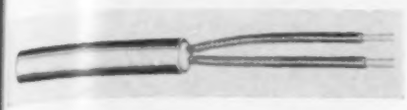
Readers' Service Item E-5

Enclosed Electric Heating Unit

A new cartridge heating unit which reportedly produces five times the heat emitted from standard units of similar size has been introduced by Watlow Electric Mfg. Co. Designated the Firerod, the unit is said to provide new highs in watt densities and temperatures, plus a longer cartridge life.

Basically, the quality of any enclosed electric heating unit is determined by the rate of heat transfer from the resistance wire to the dissipating surface of the unit, and the closeness of wire temperature to sheath temperature. Firerod claims a lower internal-wire temperature for comparable watt operating densities, plus the ability to operate at higher sheath temperatures. These two factors combine to produce an economical unit requiring less space and offering more heat than conventional units.

A test unit, measuring ½-inch O.D. by 2¼ inches long, was operated in open air for periods up to 720 consecutive hours



Watlow Firerod cartridge heating unit

at a sheath temperature of 1,800° F. Another test showed the Firerod rated at 375 watts per square inch while operating in a steel block with a clearance of five mils. At this density, a ½-inch O.D. by 2¼-inch unit had a rating of 1,030 watts, as opposed to 120 watts for a standard ½-inch O.D. by 2⅜-inch unit.

Firerods are available in standard, moisture-proof, Teflon-sealed, and special units. Sizes range from 1¼-12 inch lengths with ¼-½ inch diameters for standard units; other lengths are available on special order. Watlow engineers will determine size and number needed on customer request.

Readers' Service Item E-6

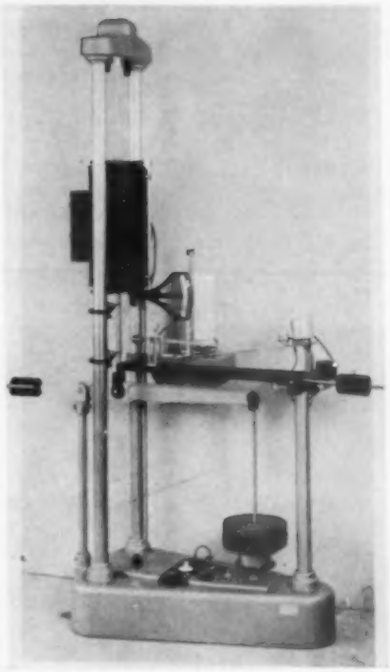
Plastics Rheograph

A rheograph for determining the hot tensile strength of plastic materials by the flow method has been developed by the A.D.A.M.E.L. Co., in collaboration with the Centre d'Etudes des Matieres Plastiques; both of Paris, France. Designated Type TM-P, the tester is available f.o.b. French port, with about three months' delay in delivery.

Adaptable to all low load tests by means of special anchoring heads, it registers elongation as a function of time. The mounted sample is enclosed in a small stove which slides up and down between two vertical columns; a cross-piece over the columns housing the anchoring device for the upper part of the sample. The stove is automatically heated by a resistance wire to temperatures as high as 300° C., and a constant temperature maintained subject to a constant force. The device records by means of two sensory perceptors which contact the sample heads, and transmit their displacements to a Chevenard extensometer.

A plate, integrally joined with the lower part of the anchoring device, permits direct loading of samples weighing up to 120 kgs. A special jack is positioned 1.5 mm. from the plate by means of an electrical device, thus preventing severe impacts when the test samples break. An amplifying lever allows the load to be raised to 500 kgs. for materials which do not flow readily.

The extensometer is connected in series with a sliding contact electrical amplifier, and elongation can be amplified 50, 100, or 200 times. A two-speed synchronized motor actuates the recording pen and causes the cylindrical chart to make a complete revolution in either 24 or 192 hours.



Type TM-P Plastics Rheograph

The machine operates at 110 volts, requiring about 500 watts. Electrical connection is automatically severed when the sample breaks.

Readers' Service Item E-7

Another Reason Why . . .

DME EJECTOR PINS

. . . are the Finest Made

SOLID FORGED HEADS

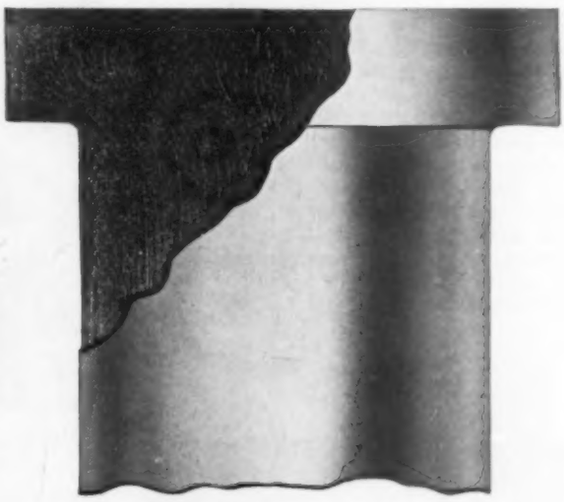
FOR ADDED STRENGTH!

You get the maximum in tensile and fatigue strength with D-M-E Ejector Pins because the heads are SOLID FORGED and annealed. As the illustration shows, the continuous unbroken flow lines follow the contour of the head to eliminate the areas of weakness along which shear can occur. In addition to this the 1/32" (maximum) radius under the head greatly reduces stress concentration at this critical section.

Yes . . . two heads are NOT ALWAYS better than ONE, especially if the ONE is a D-M-E Ejector Pin head!

42 Standard Diameters from 1/16" to 3/4"

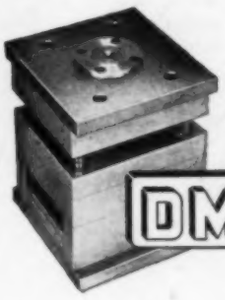
IMMEDIATE DELIVERY . . . 5 BRANCHES



CROSS-SECTION OF D-M-E EJECTOR PIN SHOWING FLOW-LINE PATTERN. PHOTO-MICROGRAPH ENLARGEMENT MADE BY THE DETROIT TESTING LABORATORY.

COMPLETE DATA ON PAGE 142 AND 143 OF THE D-M-E CATALOG. OR . .

. . WRITE TODAY FOR THE 8 PAGE EJECTOR PIN DATA FILE!



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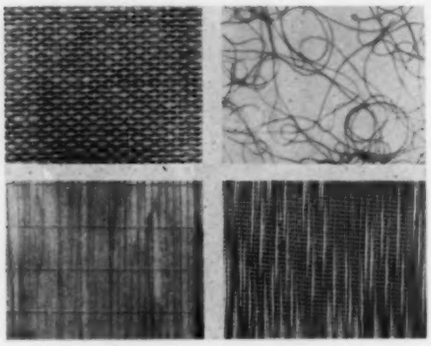
CLEVELAND 14, O.—D-M-E CORP. 5473 LAKE CT., ENDICOTT 1-0907

LOS ANGELES 7, CAL. 3700 SOUTH MAIN STREET, ADAMS 3-8214

New Products



Typical Lam-O-Wall patterns

Rigid Vinyl Wall Covering

A new type of wall covering which incorporates threads, leaves, grass, and other fragile materials between sheets of Bakelite's rigid vinyl resin has been designed and produced by Laminated Plastex Corp. Opaque sheets are used to supply eight different background colors, and a transparent overlay preserves and protects the material.

The wall covering is available as full-rigid, semi-flexible, and fully-flexible sheets, each measuring 42 by 62 inches, and trimmed to cover 18 square feet. The standard thickness of 0.0175-inch reportedly gives depth and permanence to the color and pattern. Designated Lam-O-Wall, the sheets are marketed in three surface textures: satin, semi-glossy, and rough. An all-purpose adhesive for use on wood, plaster, or brick has been prepared by the manufacturer to obtain a firm, moisture-resistant bond.

Readers' Service Item P-1

Alumin-Aire Reinforced Plastic Luggage

Reinforced Plastic Luggage

Break-, dent-, and warp-resistant luggage, molded from fibrous glass and American Cyanamid's Laminac polyester resin, is now available through Alumin-Aire Luggage, Inc. Despite its strength, the luggage is extremely lightweight, a ladies' 21-inch weekend case weighing 7¾ pounds.

Colors are molded directly into the luggage, so that it cannot chip or peel. The manufacturer guarantees each piece of luggage against breakage on any airline, railroad, or ship anywhere in the world. The complete line includes both men's and women's cases in sizes from 14-29 inches. All hardware is stainless aluminum.

Readers' Service Item P-2

Handbag made with Vynavue laminate

Vynavue Laminated Handbags

Colorful summer textiles are laminated by Fabric Leather Corp. between layers of Bakelite's Krene vinyl plastic to make ladies' handbags guaranteed not to soil or smudge. Even grease, tar, and the most stubborn chemical stains rub off with a damp cloth.

Light summer fabrics would be easily soiled and torn were it not for the durable protection afforded by the vinyl plastic. The finished laminate is designated Vynavue.

Readers' Service Item P-3

Plastic window box

Reinforced Plastic Window Box

A lightweight, one-piece, window flower box molded from glass-reinforced Vibrin polyester resin has been introduced by U. S. Fiber Glass Co. Weatherproof, corrosion-resistant, and easy to clean, the box measures 24 inches by 8 inches and is 6½ inches high.

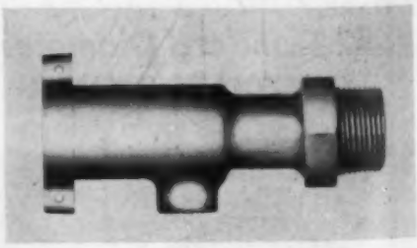
The boxes weigh less than three pounds, and can be attached to the side of the house with light brackets or fastened directly with wood screws. Color is molded directly into the box, which will be marketed in light green, pink, pale blue, and white. Vibrin is supplied by Naugatuck Chemical Division, United States Rubber Co.

Readers' Service Item P-4

Polyethylene Drum Faucet

A full-sized polyethylene faucet designed to fit all ¾-inch standard drum openings has been introduced by Multi-Meter Corp. The new faucet is said to be more durable, more economical, and lighter than the metal faucets currently being used.

Resistant to strong acids, alkalies, and oils, the faucet operates smoothly regardless of the temperature or type material with which it comes in contact. The faucet is marketed in a bronze color, special colors being available in quantity orders.



Multi-Meter's polyethylene drum faucet

Readers' Service Item P-5

Sanco's Turbine Lawn Sprinkler

Turbine Lawn Sprinkler

A red Tenite butyrate spinner head replaces the die-cast aluminum head formerly used with Sanco Products Co.'s Turbine Lawn Sprinkler. Corrosion-resistant and requiring no lubrication, the plastic head sends a shower of water over a circle 4-30 feet in diameter.

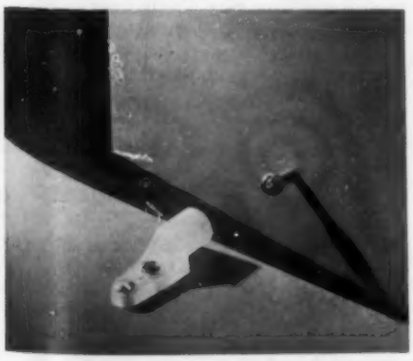
The sprinkler weighs approximately a pound, including the green, runner-type base of cast iron. The die for the spinner head was cast by Nosco Plastics, Inc., for use with Eastman Chemical's Tenite #2.

Readers' Service Item P-6

Polyethylene Friction Catches

New friction catches of Eastman Chemical's Tenite polyethylene are being molded by Plastiglide Mfg. Corp., for distribution by Jaybee Mfg. Corp. Designed to hold cabinet doors tightly closed, the catch consists of a cup-like piece which slips over a rounded screw fixed in the door. The catches are available in two types, cone-shaped and exposed, and are fastened to the cabinet shelf.

Noiseless in action, the catches are guaranteed to hold their shape and friction power indefinitely; resiliency and toughness being well-known polyethylene properties.



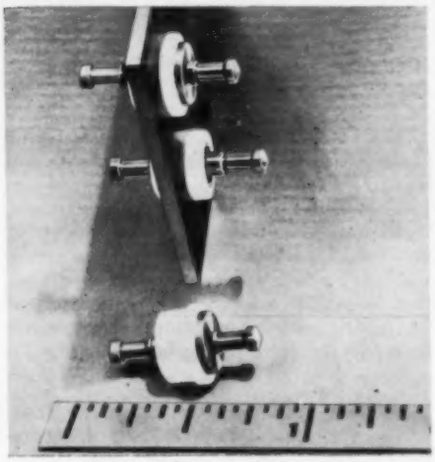
Exposed type polyethylene friction catch.

Readers' Service Item P-7

Teflon Insulator Terminals

Stand-Off and Feed-Thru insulator terminals are being produced to specification by Tri-Point Mfg. & Developing Co., Inc., Brooklyn, N. Y. Made of Teflon, the terminals offer permanent, 10-pound minimum pull test, "press-fit" installation, thus reducing assembly and parts costs in high and ultra-high frequency applications.

Miniaturization is readily accomplished due to the material's dielectric constant of 2.0 and loss factor of 0.005, which are unaffected at temperatures of 80-400° F. The company will furnish quotations for any submitted specification.



Tri-Point's Teflon insulator terminals

Readers' Service Item P-8

Allyl Resin Safety Lenses

Safety prescription lenses, said to possess twice the strength of heat-treated glass but weighing only 40-50% as much, have been developed by United States Safety Service Co. Composed of an allyl resin material named Optilite, the lenses are also reported to be more resistant to chemicals and solvents than glass; to have improved abrasion resistance; to be unaffected by extreme temperature changes; to filter out ultra-violet rays; to transmit light better; and to reduce fogging due to their thermal conductivity which is 60-75% less than that of glass.

Only under extreme impact test conditions does the material shatter, the company says, then yielding larger and less sharp segments than would result from glass. Optilite is said to meet all the current requirements of accepted ophthalmic standards and federal specifications. Lenses are available in a wide corrective range, including bifocals, and in tints of white, rose, or green.

Readers' Service Item P-9

Tenite Insulating Bushings

Chip-proof Tenite acetate insulating bushings molded with 95° free-starting threads and indented ribs are available through Electrical Fittings Corp. Designated Efcor, the fittings come in 12 different sizes ranging from ½-6 inches.

Easily screwed onto the conduit ends to protect electrical wiring, they show the following test specifications:

Tensile, compress. strength, psi.	4,200
Dielectric strength, v/m	325
Specific gravity, gms	1.19
Water absorption, %	1.40
Dissipation factor	0.025
Dielectric constant	4.5

Approved by Underwriters' Laboratories for use with two locknuts, the bushings will not support combustion and show no distortion at heats up to 70° C. Reportedly unbreakable, the bushings can be loosened by a screwdriver. Tenite acetate is supplied by Eastman Chemical Products, Inc.

Efcor cellulose insulating bushings.

Readers' Service Item P-10

Disposable Plastic Syringes

Disposable syringes, molded from Tenite polyethylene by Artcraft Plastic Moulders, Ltd., provide a handy means of dosing cattle with antibiotics or sulfa drugs. Consisting of a semi-rigid barrel and plunger, the syringes are unbreakable, light in weight, and easy to handle.

Delta Laboratories fill the syringes with a single dosage and distribute them through veterinary concerns. Ready for use, the syringes have a shelf life of 18 months. Tenite polyethylene is marketed by Eastman Chemical Products, Inc.

Disposable Polyethylene Syringes

Readers' Service Item P-11

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Book Reviews

"Surface Coating Resin Index." British Plastics Federation, 47 Piccadilly, London W.1., England, and Surface Coating Synthetic Resin Manufacturers Assn., 79-80 High Holborn, London WC.1., England. Paper, 5¾ x 8¾ inches, 55 pages. Price, 3s.

The booklet consists of 14 tables listing basic information on the 733 surface coating resins available to the British trade. Listings are alphabetical by trade name. Among the data included are: producer, % non-volatile, solvent, maximum acid value, viscosity, white spirit tolerance, composition, solubility, and melting point. Indexes of trade names and manufacturers are found in the back of the booklet.

"ASTM Standards on Electrical Insulating Materials (With Related Information)." The American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Paper, 6 by 9 inches, 660 pages. Price, $5.50.

Prepared by ASTM Committee D-9 on Electrical Insulating Materials, this latest volume includes 60 test methods, 17 specifications, three recommended practices, and a list of definitions. Thirty-three of the designations are new or have been revised since the last edition.

Included also are two proposed methods, which are published in draft form for the purpose of soliciting comments. In addition a complete list of Committee D-9 members is appended.

"The Testing and Inspection of Engineering Materials." Harmer E. Davis, George Earl Troxell, and Clement T. Wiskocil. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. Cloth, 6¼ x 9½ inches, 446 pages. Price, $6.50.

General concepts and principles of materials testing are covered, including a description of commonly used tests, the equipment in regular use, and the many variables affecting test results. This provides a basis for intelligent inspection and preparation of adequate, enforceable specifications.

New procedures and equipment, such as micro-hardness testers, low temperature impact tests, true stress-natural strain relationships, and electrical strain gages, are discussed in a separate section along with non-destructive tests using ultrasonics and penetrants for uncovering structural defects.

Intended primarily as an introductory work for students, the book should also be of interest to management and production executives, sales and technical service personnel, and purchasers of equipment. Voluminous periodical literature has been abstracted, and a classified list of references is appended. A summary of material properties for use in estimating load schedules is included.

"Encyclopédie Française des Matières Plastiques." Published under the auspices of the Union des Syndicats de la Transformation des Matières Plastiques and the Centre d'Etude des Matières Plastiques by Les Publications Techniques Associées, 40 Rue du Colisée, Paris 8, France. Paper, 9½ by 12¼ inches, 496 pages. Price, 3,400 francs (about $10).

The first of the nine parts that make up the encyclopedia is entitled "What should be expected from the plastics industry?" This question is anwered by stating the position of the industry and giving a general idea of plastics, their properties and applications, thereby providing a preview of the contents of the book.

Specific treatment is given in the succeeding six parts to the basic materials involved (primary materials, intermediates, catalysts, fillers, plasticizers, etc.); the preparation and uses of thermoplastic and thermosetting materials, with a table showing the average properties of the principal plastics, chiefly in the molded state; common forms of semi-finished products (laminates, sheets, fibers, foams, adhesives, and coatings); testing and standardization (almost half this section describes the advantages of small samples, especially in impact testing, and the advantages of type-objects for comparing different materials and molding methods); processing methods (the longest chapter, with discussions of transfer, compression, and injection molding, vacuum forming, welding, etc., and a detailed treatment of injection mold technology); and applications, a discussion of the possibilities and limitations of plastics from the engineer's viewpoint, and including details on the use of plastics in a number of fields.

Of the concluding parts, the eighth section describes the functions and aims of the two sponsoring organizations. The last section presents buyers' guides for materials and semi-products, machinery and equipment, and finished goods, as well as the addresses of companies and an alphabetical index.

Of necessity, many aspects of the wide field of plastics are treated only briefly, but what is presented, aided by the clear language and the many illustrations, is sufficient to give a good picture of the current status of the industry and what can be expected of it in the future. (In French).

New Literature

"Reinforcement of Silicone Rubber with Teflon." George S. Irby, Jr. General Electric Co., plastics department. 8 pages. The physical properties, particularly tear strength, of silicone rubbers is reportedly improved by the milling-in of tetrafluoroethylene resin. Three formulations with their resultant improved properties are tabulated in this brochure.

Readers' Service Item L-1

"Mold and Die Making Facilities." Newark Die Co. 4 pages. This bulletin lists, enumerates, and classifies the equipment which the company has available for customer mold and die requirements.

Readers' Service Item L-2

"A New Source of Profits for Heat Treat Shops." Bulletin No. 123. American Wheelabrator & Equipment Corp. 4 pages. This illustrated bulletin describes the wet blasting process for removing scale with the company's Liquamatte machine.

Readers' Service Item L-3

"Plaskon Polyester Resins." Barrett Division, Allied Chemical & Dye Corp. 28 pages. A newly revised folder containing Technical Data Reports 55-1 through 55-12, plus a four-page brochure listing the typical properties of the resins are contained in this folder.

Readers' Service Item L-4

"Simplified Drafting." American Machine & Foundry Co. 32 pages. Eleven rules for simplified drafting are presented, and examples are depicted showing correct and incorrect applications of the rules. Each rule, plus the introductory material, is accompanied by humorous sketches.

Readers' Service Item L-5

"Riehle Testing Machines and Instruments." Bulletin RG-14-55. Riehle Testing Machines Division, American Machine & Metals, Inc. 8 pages. Brief descriptions and photographs of the company's complete line of testing machines, including those for testing hardness, compression, torsion, and tensile strength, are included in this catalog, with references to more detailed bulletins on specific devices.

Readers' Service Item L-6

"Sprits Mold Release." Sprits. 4 pages. The company's mold release, a mixture of Freons and silicones, is described in this bulletin.

Readers' Service Item L-7

"A Story of Growth." National Starch Products, Inc. 12 pages. The company's history and illustrated summaries of its products are contained in this brochure.

Readers' Service Item L-8

"Marketing and Economic Research . . . Your Problem?" Foster D. Snell, Inc. 8 pages. The firm's chemical market research system and some of its past achievements in the field are outlined here.

Readers' Service Item L-9

"Helpful Hints on Using Molded Part Grinders." Injection Molders Supply Co. 6 pages. Data on the company's Sprue and Part Grinder, Elastomeric Grinder, and 2-Stage Grinder Granulator are included in this bulletin.

Readers' Service Item L-10

"Auto-Vac Drape and Vacuum Forming Machines." Bulletin 55. Auto-Vac Co. 8 pages. The construction and operational features of the company's equipment are described and illustrated along with a number of industrial uses.

Readers' Service Item L-11

"Exon 450." Sales Service Bulletin #13. Firestone Plastics Co. 8 pages. Physical properties, solubility characteristics, and formulations for Exon 450, a vinyl chloride copolymer, are given in this bulletin.

Readers' Service Item L-12

"Acme Polyfluoron Liquid Dispersion." Acme Resin Corp. 4 pages. Composition, specifications, and applications for the dispersion are contained in this brochure.

Readers' Service Item L-13

"Silicone News." No. 15. Dow Corning Corp. 2 pages. A number of stories on silicone applications and a listing of the company's available publications are included.

Readers' Service Item L-14

"Synpro Metallic Stearates." Synthetic Products Co. 26 pages. This bulletin gives the history of the company, an illustrated description of the new plant and laboratory, and specifications of the company's stearate material. A breakdown of the methods used in their analysis is also included. In addition to eight metallic stearates, Synpro manufactures metallic soaps, protective coatings, and vinyl plasticizers.

Readers' Service Item L-15

"Acme Polyfluoron Molding Powder." Acme Resin Corp. 4 pages. This bulletin gives the chemical, physical, and electrical properties; applications; and techniques for extruding and molding Polyfluoron granules and powder.

Readers' Service Item L-16

"Nodular Iron for Rolls and Castings." Aetna-Standard Engineering Co. 12 pages. The chemical composition and mechanical properties of the firm's various types of nodular iron, as well as roll and casting applications, are included here. Extensively illustrated with photographs of foundry operations and end products.

Readers' Service Item L-17

"Swivel Joints for Piping." Catalog No. 265-B (revised). Barco Mfg. Co. 12 pages. Specifications, dimensions, and applications of the company's movable joints for chemical, heating, process, power, and hydraulic piping are contained in this booklet.

Readers' Service Item L-18

"Propylene Glycol." F-8738. 16 pages. Specifications, solubilities, constant-boiling mixtures, and applications of propylene glycol are contained in this data folder. The material is a raw material for polyester resins, an intermediate for plasticizers, and a solvent and humectant. Eight physical property charts are included.

Readers' Service Item L-19

"Spray Masks." William M. Fiore, Inc. 20 pages. A two-color illustrated brochure which defines the major types of masks used for spray-decorating plastics, diecastings, and metal stampings. Roller inkings are discussed, and mask suitability is outlined by product.

Readers' Service Item L-20

"The 'How' Book for Heating Cylinders." Injection Molders Supply Co. 32 pages. A profusely illustrated booklet describing the company's replacement cylinders and superheaters, with details on installation, operation, and maintenance. Special vinyl, butyrate, and Kel-F molding applications are covered, as are welding techniques.

Readers' Service Item L-21

Abstracts of Important Articles

MATERIALS

"Some Possibilities for the Production of Substituted Styrenes," J. A. Vega and C. G. Blairsy, *Rev. de Plasticos (Spain)*, 6, 31, 4 (Jan.-Feb. 1955).

The possibilities for obtaining isopropenyl toluene and p-methyl styrene (or vinyl toluene) from p-cimene are discussed. The properties and present and potential uses of the monomers are briefly indicated, as well as the resins made from them. (In Spanish).

"Glass Fibers for Reinforcing Plastics," O. Meyer, *Kunststoff-Rundschau*, 2, 3, 74 and 2, 4, 109 (March-April 1955).

The production of fiber glass products and the advantages of different weaves are discussed. The mechanical properties of the glass, in particular, as well as its chemical properties, are treated in considerable detail. (In German).

"The Theory of the Movement of Material in Screw Machines. The Flow Process of Newtonian Liquids in Single-Screw Pumps," W. Muskat, *Kunststoffe*, 45 3, 87 (Mar. 1955).

This first of a three-part article deals with the theory of movement of materials in screw machines, a recently published French dissertation by Maillefer, and new American work on the subject. It is shown that in all these investigations the fundamental equations are derived from the linearized Navier-Stokes differential equation and that, therefore, only Newtonian liquids have been considered. In continuing the theoretical considerations, the authors based the superimposition of calculated velocity distributions on the superposition principle. Consequently, Part II will deal with the limits of the application of this principle and its extension to non-Newtonian liquids, and Part III will discuss the flow of solids in screw machines and compare it with experimental results. (In German).

"The Case for the Adoption of the British Yield Test as the I.E.C. (International Electrochemical Commission) Standard," A. Morris Thomas, *Brit. Plastics*, 28, 3, 113 (March 1955).

Proposals for an inter-nation yield test are now under consideration by the I.E.C. Evidence is presented to show that the British test is probably as good as any and, hence, to be preferred as an International Standard.

Processing True Plastigels Based on P.V.C.," J. Delorme, *Ind. Plastiques Mod.*, 7, 3, 27 (March 1955).

In previous articles, the author discussed his method of producing PVC plastigels in which plasticizers are directly absorbed by the surface of the resin particles in the absence of a liquid phase. Such "true" plastigels are not distorted during curing, which only causes penetration of plasticizer in the resin particles. Consequently, plastigels with very low plasticizer content can be made, it is claimed. The materials are said to be particularly suitable for making thick parts or pieces with large surfaces, which are impossible or costly to make by the usual methods. The equipment needed for these plastigels differs from that usually employed for PVC only as to temperature requirements, since cold molds must usually be employed. (In French).

"Method to Determine the Flow Characteristics of Hardenable Molding Compounds," C. M. V. Meysenbug, *Kunststoffe*, 45, 2, 48 (Feb. 1955).

Investigations at Darmstadt led to the development of a new method (based on the original ASTM Flow Test) and a new device for testing molding compounds in the form of chips as well as of powders. The apparatus is designed to permit comparable tests of the two types of materials to be made on the same machine under the same loads and with the same flow channel cross-section. The versatility of the method and the reproducibility of results are demonstrated by several examples. (In German).

"Plastics for the Jet Age," Geoffrey Gee, *Rubber Journal*, 128, 9, 263 (Apr. 1955).

A generalized discussion of the problems encountered in high and low temperature applications of plastics in the aircraft industry, particularly with respect to lubricants and plasticizers.

Requests for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines wil be printed here quarterly.

—The Editor

"The Strength of Heat Cleaned Glass Cloth," F. F. Jaray, *Brit. Plastics*, 28, 4, 155 (April 1955).

The effects on tensile strength of flaws, air bubbles, surface treatment, and immersion in water are discussed in simple terms.

"Color, Paint, and Plastics," Lloyd E. Parks, *Modern Plastics*, 32, 9, 99 (May, 1955).

Formulations for spray and silk-screen applications, and finishes for vacuum metallized surfaces are covered in this article, including resin and solvent systems, pigments, bleeding, blush, etch, and crazing.

"Hardness Testing of Plastics," Bryce Maxwell, *Modern Plastics*, 32, 9, 125 (May, 1955).

Anomalies of indentation hardness were studied to determine what physical constants are responsible for resistance to indentation. Basic theory is presented and modulus-hardness correlated, as determined by Rockwell M, alpha Rockwell, Shore Scleroscope, torsion-spring rebound, and low-energy rebound tests. It was determined that test results are dependent on both time and temperature.

"Sorption of Water by Polymethyl Methacrylate," G. M. Brauer and W. T. Sweeney, *Modern Plastics*, 32, 9, 138 (May, 1955).

The kinetics of vapor sorption by polymer films show that changes in diffusion occur in the region of glass temperature of the polymer-penetrant mixture. In the case of polymethyl methacrylates, sorption is nearly independent of temperatures from 0-60° C. In the vicinity of glass temperature, sorption increases rapidly; above, steady state sorption values are not obtained, probably due to the less rigid linkage in the polymer chains and an expansion of the structure.

"On the Isothermal Variation of the Volume of High Polymers," A. J. Kovacs, *Ind. Plastiques Mod.*, 7, 1, 30; 7, 2, 39; and 7, 3, 36 (Jan.-March 1955).

When cooled below a certain temperature, the value of which depends on the rate of cooling, linear high polymers cease to be in a true thermodynamic equilibrium. For an amorphous polymer (polystyrene), this temperature characterizes the transition of the supercooled liquid to the vitreous state. For a crystallizable polymer (polyethylene), this temperature characterizes the appearance of the crystalline phase. If after cooling or quenching, these materials are maintained at a constant temperature, they tend toward the new thermodynamic equilibrium, generally only after a very long time. During this period an isothermal volume contraction is observable. (In French).

UNIVERSITY OF MICHIGAN • ENGINEERING

EQUIPMENT

"Temperature and Pressure Measurements in the Injection Machine Heating Cylinder," C. E. Beyer, R. B. Dahl, and R. B. McKee, *Modern Plastics*, 32, 9, 110 (May, 1955).

A method of making quantitative measurements on the heating cylinder of an injection molding machine involves the temperature of the plastic. A thermocouple of sufficient rigidity and accuracy was found best for measuring temperature under existing conditions. Flow characteristics found with various heating cylinders are also discussed.

"Picture of a Modern Plastics Extruder," H. W. Adams, *Kunststoffe*, 45, 3, 97 (Mar, 1955).

A description of the design of a new series of extruders with screw diameters of 60 and 90 mm. A table of the most important data is included. (In German.)

"Urgent Extrusion Problems," H. Reifenhauser. *Kunststoffe*, 45, 3, 93 (March 1955).

The author deals with the problems presented by the new plastics and describes some of the newest equipment for producing film with the aid of wide slit dies, and film from blown or spread tubing. (In German.)

"Construction of Molds for Injection Molding Machines. Molds for Parts with Slide as second plane of partition," H. Gastrow, *Kunststoffe*, 45, 2, 81 (Feb. 1955).

A brief description. (In German.)

"Recent Developments in Calenders for P.V.C.," R. S. Colborne, *Brit. Plastics*, 28, 4, 134 (April 1955).

The latest designs in use in America, Britain, and Germany are dealt with. It is pointed out that in the latter two countries, new features have been introduced which in some respects are in advance of American practice. The use of separate motors for calender rolls seems to be confined to Europe, and may be due to a difference in market requirements.

"Cold Hobbed Molds for Compression and Injection Molding Compounds," C. Ostmann, *Kunststoffe*, 45, 2, 77 (Feb. 1955).

Cold hobbing of molds frequently offers considerable advantages over milling or copy milling through speedier and cheaper production. However, various precautions are necessary to obtain accurately dimensioned molds. These are discussed and several molds are shown which have been produced by cold-hobbing. (In German.)

"Heating Cylinders for Injection Molding Machines." H. Gastrow, *Kunststoffe*, 45, 3, 122 (March 1955).

After discussing the factors governing the efficiency of heating cylinders, the author describes a design for providing maximum heating surface by means of a flared heating chamber with heating ribs on the external walls and on the torpedo (in the case of large heating cylinders) in combination with three mixing compartments. This design gives a short heating cylinder with large heating surface and relatively small load capacity. (In German.)

"Recent Developments in Flame-Spraying and Whirl-Sintering," E. Gemmer, *Plastverarbeiter*, 6, 3, 82 (March 1955).

Whirl-sintering is a German development about three years old in which plastic powder is whirled by compressed air and blown with inert gas so that the powder resembles a fluid in which the heated and previously roughened part can be dipped so that a layer of plastic melts on their surfaces. The methods and apparatus of flame-spraying and whirl-sintering are described, including a device which combines both methods. (In German.)

PROCESSING

"Method of Constructing and Calculating Reinforced Polyester Tubes," J. A. Taviere, *Ind. Plastiques Mod.*, 7, 3, 25 (March 1955).

Fiber glass is wound around a wood or metal mandrel, and automatically impregnated with polyester resin as it unwinds. The tube then passes through a curing chamber at the other end of the machine. A formula is given by which the ratio of spirally- to longitudinally-wound threads can be calculated for a given bursting and flexing strength. (In French.)

"Effects of Mold Temperature on the Behavior of Thermoplastics," *SPE J.*, 11, 5, 22 (May, 1955).

Engineering's role in the plastics processing field is one of arranging control factors in accordance with their position of dominance. Factors discussed here are resistance to plastic flow, physical properties of the molding, surface finish, and length of the molding cycle.

APPLICATIONS

"Possible Uses for Melamine Resins," E. Doeblemann and H. G. Knoblauch, *Kunststoff-Rundschau*, 2, 2, 37 (Feb. 1955).

A review of the properties and possibilities of melamine resins as molding compounds, in laminations, as adhesives, and for improving paper, textiles, leather, etc. (In German.)

"Vinyl Coatings' Biggest Drawback Licked," Kenneth Tator, *Chem. Eng.*, 62, 5, 228 (May, 1955).

Three years ago the principal disadvantage of vinyl coatings was their low build-up per coat; five or six coats were required to achieve a 5-mil thickness. Hot-spray applications and the use of mastic fillers to increase viscosity have made it possible to obtain applied coatings of two mils or more per coat.

"Plastics in Electrotechnics," F. Falkenberg, *Kunststoff-Rundschau*, 2, 2, 40 (Feb. 1955).

The chief polymerization and condensation products used for electrical purposes are reviewed from the standpoint of their chemistry, physical properties, and fields of application. (In German.)

"Flexible Insulations," P. Ayasse, *Ind. Plastiques Mod.*, 7, 2, 18 and 7, 3, 7 (Feb.-March 1955).

The requirements as to the supporting materials, varnishes, and methods of coating for flexible insulations are reviewed, and the various types classified as to electrical, mechanical, and chemical properties. (In French.)

"Synthetic Resins for Plastic Finishes," C. Roethgen, *Kunststoff-Rundschau*, 2, 1, 7, (Jan. 1955).

The use of various vinyl polymers in solutions and as dispersions, either alone or in combination with other finishing materials, is discussed. Because of their compatibility with many other basic materials for paints and finishes, the polyvinyl-acetates find far greater use in this field than do the other vinyl polymers. (In German).

"Design of an Automobile Body of Reinforced Plastic," J. Biroult, G. Bony, and R. Debakere, *Ind. Plastiques Modernes*, 7, 2, 1 (Feb. 1955).

Details are given of the construction of parts for an experimental body for a Renault 4 C.V. car, made from a sandwich structure of two sheets of reinforced polyester with a core of ground cork-polyester mix. The car features a one-piece molded base, and twin seats molded in one piece. (In French).

GENERAL

"Significance," Gilbert L. Peakes, *SPE J.*, 11, 5, 11 (May, 1955).

The ninth in a series of articles on statistical quality control, it deals in a general way with the significance of the tests, with reference to texts containing numerical tables and instructions. Type tests discussed include: comparison of an average with a standard; comparison of one average with another; comparison of one dispersion with another; and comparison of actual counted objects or events with expected counts.

Patent Digest

MATERIALS

Compositions Comprising Acrylonitrile Polymers. No. 2,705,225. Ernest Jan Kowolik and James Wotherspoon Fisher, Spondon, near Derby, England. (to British Celanese, Ltd.)

The composition comprises an acrylonitrile polymer and an acyloxy alkyl mononitrile containing up to five carbon atoms in the molecule.

Process for the Manufacture of Substituted 4-Methyl Coumarins. No. 2,704,766. Herbert Nordt, Koln Mulheim, and Detlef Delfs, Leverkusen-Schlebusch III, Germany. (to Farbenfabriken Bayer Aktiengesellschaft, Leverkusen, Germany.)

A phenol containing a methyl and 1-3 hydroxyl groups is reacted with diketene in the presence of an esterification catalyst at a slightly elevated temperature to form a monoacetate of the phenol. The monoacetate is condensed by dehydrating the condensing agent.

Thermosetting Resinous Compositions from Epoxy Resins and Polyamides Derived from Polymeric Fat Acids. No. 2,705,233. Malcolm M. Renfrew and Harold Wittcoff, Minneapolis, Minn. (to General Mills, Inc., Minneapolis, Minn.)

The composition consists of terminal epoxy groups and a polymeric polyamide curing agent which is the reaction product of polymeric fat acids containing at least two carboxyl groups, and an aliphatic polyamine.

Stabilization of Polystyrene. No. 2,704,749. Ernest H. Wood, Westfield, N. J., and James R. Wilkinson, Milwaukee, Wis. (to Union Carbide & Carbon Corp., N. Y.)

The composition contains polystyrene and from 0.1-5% of a resorcinol dibenzoate polystyrene or resorcinol disalicylate polystyrene. It is characterized by stability against deterioration upon weathering and exposure to ultraviolet light.

Stabilized Solutions of Mixtures of Polyamide Resins and Epoxy Resins. No. 2,707,708. Harold Wittcoff, Minneapolis, Minn. (to General Mills, Inc., Minneapolis, Minn.).

A stabilized organic-solvent solution of an epoxy resin and a polyamide is obtained by adding 1-30% formaldehyde by weight.

Non-Electrostatic Resinous Molding Compositions. No. 2,707,709. Rolf Buchdahl, Longmeadow, and Massimo Baer, Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

The composition consists of 50-70% polystyrene and 30-50% amine salt of sulfonated polystyrene, the salt having a softening point of less than 225° C.

Printing on Vinyl Plastics. No. 2,708,188. Gabriel F. Goldstein, New York, N. Y. (to Interchemical Corp., New York, N. Y.).

A printing composition for vinyls consisting of a volatile, water-immiscible, organic solvent solution of vinyl chloride-vinyl acetate copolymer; a mixture of lower alkyl methacrylate resins with 20-60% drying oil-modified alkyd resin; and copolymers of a lower alkyl methacrylate with the oil-modified alkyd.

Biuret-Urea Blowing Agent Used for Producing Cellular Materials. No. 2,707,707. Herbert F. Schwarz, Chicago, Ill. (to Sherwin-Williams Co., Cleveland, O.).

A gas-producing composition, containing biuret and at least 1% urea by weight, is incorporated into a millable polymer which is plastic at temperatures of 266-350° F., in the ratio of 4-15 parts per 100 parts by weight of the polymer.

Organo-Polysiloxane Compositions Containing an Ethanolamine and Benzoyl Peroxide and Their Manufacture. No. 2,707,179. Pierre Pascal Peyrot, Lyon, and Louis Jean Dumoulin, S/Dorlay, France. (to Societe des Usines Chimiques Rhone Poulenc, Paris, France.).

The compound contains 0.25-4% ethanolamine, 1-6% benzoyl, peroxide, and the balance methyl or methylphenyl polysiloxane resins, wherein the ratio of organic substituent groups to the number of silicon atoms is between 1.4:1 and 1:1. The composition is stabilized against deterioration on storage.

Tricresyl Phosphate-Chlorinated Biphenyl Functional Fluid Improved by Alkylated Polystyrene. No. 2,707,176. Harry R. Gamrath and Roger E. Hatton, St. Louis, Mo. (to Monsanto Chemical Co., St. Louis, Mo.).

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

The fluid comprises 40-55 parts tricresyl phosphate by weight, 45-60 chlorinated biphenyl, and 0.4-2 parts alkylated polystyrene. The viscosity at 100° F. should range from 150-1,200 S.S.U., and the viscosity index from 0-150.

Ethoxyline-Triallyl Cyanurate Resinous Compositions. No. 2,707,177. Russell A. Skiff, Waterford, and Robert W. Finholt, Lawrence Park, Pa. (to General Electric Co., Schenectady, N. Y.).

The composition comprises triallyl cyanurate and a complex epoxide resin which is a polyether derivative of a polyhydric organic compound containing epoxy groups and at least two phenolic hydroxy groups.

Stabilizers for Vinyl Chloride Resins. No. 2,707,178. Joseph Edward Wilson, New Brunswick, N. J. (Union Carbide & Carbon Corp., New York, N. Y.).

A polyester condensation product of an aliphatic mercapto alcohol and a dicarboxylic acid is added to a chlorine-containing polyvinyl resin in the proportion of 0.01-5:100.

EQUIPMENT

Injection Molding Machine. No. 2,704,380. Albert Cuzzi, Milan, Italy.

The heated outer tubular member has an axially extending bore for the first cylindrical main portion, a second portion of smaller diameter, and a tapered intermediate portion. An inner tubular member is rotatably mounted in the cylindrical portion defining an annular space with the intermediate section. A helical groove of uniform pitch with a depth decreasing from one end is formed in the tubular member to accommodate the plastic material, which is driven into the annular space and through apertures to the second portion of the bore. A reciprocating piston opens and closes the apertures.

Mechanism for Forming Indentations in a Moving Rod of Plastic Material. No. 2,704,520. Alfred German Rose and Sidney Curtis, Gainsborough, England. (to Rose Brothers, Ltd., Gainsborough, England.)

Three or more marking rollers are rotatably mounted for movement about axes in a common plane. The rollers have shaped peripheral surfaces corresponding to the plastic rod which passes between them. Radial slots at equal circumferential distances house marking knives with cutting edges parallel to the axes. The knives are arranged to register with the knives of the other rollers as they pass through the plane in which the aperture is defined.

Thin Shell Dies and Method of Making Same. No. 2,706,832. Louis E. Frost, Los Angeles, and George B. Lewis, Venice, Calif. (to North American Aviation, Inc., Los Angeles, Calif.).

The die comprises plastic lamina with tubing circling and attached thereto by means of a plastic mastic and metallic dust.

UNIVERSITY OF MICHIGAN LIBRARIES

Loading and Unloading Mechanism for Multi-Platen Presses. No. 2,704,608. John C. Graf, Philadelphia, and John R. Graf, Abington Township, Pa.

The mechanism consists of an elevator in alignment with the front of the press and accessible for loading. The shelves are vertically spaced to register with the intervals between the press platens when the press is open. A charging table is positioned laterally to the loading side of the elevator which moves step-by-step to bring its shelves level to the table for sheet feeding. An injector pushes the sheets into the press when the elevator is charged.

Mold. No. 2,707,801. George E. Gard, East Hempfield Township, Lancaster County, Pa. (to Armstrong Cork Co., Lancaster, Pa.).

A mold for confining a charge of dielectric material during processing by dielectric heating has the combination of a mold side wall consisting of hardwood impregnated with a waterproofing agent and having a dielectric loss factor between 0.1-0.4, and a dielectric liner. The liner constitutes one quarter of the wall's thickness, and may consist of fluorocarbon, silicone, melamine, or nylon material. Its dielectric loss factor should be between 0.001-0.1.

Mold with a Vented Liner. No. 2,707,802. George E. Gard, East Hempfield Township, Lancaster County, Pa. (to Armstrong Cork Co., Lancaster, Pa.).

The mold is similar to that of No. 2,707,801, except that the dielectric liner is minutely pervious to moisture, but not to the material. In addition, the liner has a plurality of artificially-formed openings for the escape of gases and vapor.

Method and Apparatus for Molding Plastic. No. 2,708,288. Frank W. Fuller and Gardner B. Moore, St. Paul, Minn.

The mold structure includes a base, a means for heating the base, and a supporting means on the base for a mold pan. This minimizes heat transfer from the base to the pan. The pan, however, can be brought into contact with the base when desired.

Molding Apparatus. No. 2,706,830. Harry H. Holly, Chicago, Ill. (to Hollymatic Corp., Chicago, Ill.).

An apparatus for molding successive portions of a plastic material includes a hopper, a feed exit, a mold connected to the hopper exit, and a feeder means in the hopper movable toward and away from the feed exit for moving the material. A drive apparatus operates the feeder, and a spring exerts a predetermined force on the feeder, causing it to expel the material through the exit.

Moulds for Thermoplastic Materials. No. 2,707,803. Beryl Freda Thorne, Lewisham, London, England. (to Telegraph Construction & Maintenance Co., Ltd., London, England.).

A mold for making a welded joint of thermoplastic material comprises a relatively stationary mold housing, a revolving inner mold element for enclosing the article to be welded, entrance ports both in the mold housing and in the mold element by which a heating fluid can be admitted, and a means for rotating the mold element to vary the point of entry.

Means for Forming Patterns and Molds. No. 2,706,309. James A. Lampman, Inglewood, Calif. (to Northrop Aircraft, Inc., Hawthorne, Calif.).

The mold-forming device comprises an impermeable foundation member; a sheet of flexible impermeable material positioned above and detachably clamped around the peripheral edge of the foundation member, thus defining a fluid tight chamber; a means for defining a contour surface fixedly spaced above the foundation member and engageable by a part of the sheet material; and a means for effecting a differential pressure between the chamber and exterior to force the sheet into engagement with the contour surface.

PROCESSING

Process of Making Abrasive Phenolic Resin Mixes. No. 2,708,622. Hyman Nathan Stone, Worcester, Mass. (to Norton Co., Worcester, Mass.).

To prepare an abrasive phenolic resin mix for the manufacture of solid abrasive articles, finely ground abrasive is wet and mixed with powdered phenolic resin. The mix is fed, with gas and under pressure, into a fluidizing zone. Air is heated to 40-200° C., and forced upward through a porous plate and into the zone to stabilize the particles.

Method for Molding Plastic Materials. No. 2,706,843. Robert O. Davis, Adrian, Mich. (to Gene Olsen Corp., Adrian, Mich.).

Plastic building blocks of varying densities can be continuously molded by vibrating the mold and compacting the material for a predetermined length of time. The feeding time for the next cycle is adjusted in inverse proportion to any variation from the predetermined compaction time.

Formation of Films and Filament Directly from Polymer Intermediates. No. 2,708,617. Eugene Edward Magat and Donald Rittler Strachan, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

Condensation polymer films and filaments can be formed directly from intermediates by conducting an interphase polymerization between fast-reacting organic polymers at a continuing interface of controlled shape between two liquid phases. Each liquid contains an intermediate, and they react rapidly to form a shaped polymer, separating the phases and insoluble therein.

Making Films and Fibers from Normally Crystalline Polymer Latices. No. 2,707,805. Cornelius P. Smith, Fleming, and Edgar W. Le Boeuf and Otis Ray McIntire, Midland, Mich. (to Dow Chemical Co., Midland, Mich.).

The process involves depositing a thin layer of a 30%-solids polymer emulsion in which all the particles are under 2,000 Angstrom units in diameter; drying the layer; heating the film to a temperature momentarily above its melting point; cooling the film rapidly; and longitudinally stretching the film to produce crystallization and molecular orientation.

Method of Adhesively Joining Metal, Wood, and Plastic Parts. No. 2,707,694. (James Robert Standring, Bushey Heath, England.)

A method of permanently and rigidly joining two parts comprises making depressions on at least one of the contact surfaces and charging the depressions with an adhesive which is capable of releasing a gas on heating. The gas exerts a pressure which forces adhesive into the surface interstices.

Preparation of Plastics in Cellular Form. No. 2,708,661. Robert L. Frank, Lake Geneva, Wis. (to Ringwood Chemical Corp., Ringwood, Ill.).

PVC and a n-nitroso beta amino ketone are mixed with an accelerator and heated. This brings about decomposition of the ketone, and releases nitrogen which expands the mixture into a cellular structure.

APPLICATIONS

Molded Plastic Track Element for a Toy Railway. No. 2,707,606. Anthony N. Smith, Erie, Pa. (to Louis Marx & Co., Inc., New York, N. Y.).

Plastic material is integrally molded to form simulated ties and dimensioned so as to fit between the webs of the pair of rails.

Electrically Conducting Films on Cast Plastics. No. 2,704,265. Dean A. Lvon. Washington, D. C.

The surface consists of a continuous transparent layer of cuprous iodide, a bonding layer of synthetic resin, and a body of polymerized polymethyl methacrylate.

Ventilated Plastic Bag. No. 2,704,099. Richard H. Wikle, Atlanta, Ga.

The bag has reinforcing ribs formed integrally with the sheet material, some of the ribs intersecting one another. Ventilated openings are provided at the points of intersection.

Domestic Production and Sales of Plastics and Resin Material, January and February, 1955

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of January and February, 1955. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

Polyester resins for use in reinforced plastics and similar applications have been added as a new category.

	January		February	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,520,519	1,420,649	1,557,880	1,536,209
Sheets, 0.003 gage and over	1,201,385	1,060,458	1,087,250	1,119,631
All other sheets, rods, and tubes	567,948	481,372	569,860	533,127
Molding and extrusion materials	6,907,671	6,867,887	7,177,347	6,950,739
Nitrocellulose sheets, rods, and tubes	414,134	454,283	364,282	431,677
Other cellulose plastics	552,980	474,252	558,857	606,509
TOTAL	11,164,637	10,758,901	11,315,476	11,177,892
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	16,206,920	15,917,500	16,345,390	15,218,611
Bonding and adhesive resins for—				
Laminating (except plywood)	5,325,117	3,992,509	5,933,601	4,059,861
Coated and bonded abrasives	979,042	1,189,855	1,068,126	1,182,690
Friction materials (brake linings, clutch facings, and similar materials	1,703,157	1,594,609	1,938,200	1,746,276
Thermal insulation (fiber glass, rock wool)	2,801,052	2,987,473	2,997,757	3,066,197
Plywood	3,346,946	2,980,777	4,395,022	3,673,399
All other bonding and adhesive uses	1,138,545	1,249,081	1,080,812	1,105,058
Protective-coating resins, unmodified and modified except by rosin	1,959,996	1,934,224	2,279,802	1,924,877
Resins for all other uses	2,892,746	2,613,462	3,436,283	3,440,805
TOTAL	36,353,521	34,459,490	39,474,993	35,417,774
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	3,800,099	3,528,808	3,288,164	3,394,559
Paper-treating and paper-coating resins	1,542,748	1,485,564	1,763,336	1,821,155
Bonding and adhesive resins for—				
Plywood	6,916,303	6,430,586	7,680,516	6,791,343
All other bonding and adhesive uses, including laminating	2,344,034	2,317,204	2,029,973	2,090,016
Protective-coating resins, straight and modified	2,833,025	2,236,671	2,887,509	2,184,306
Resins for all other uses, including molding	6,094,572	5,894,180	5,914,349	5,857,477
TOTAL	23,530,781	21,893,013	23,563,847	22,138,856
Styrene Resins:				
Molding materials[1]	30,952,840	28,537,419	28,875,719	29,315,737
Protective-coating resins, straight and modified	7,909,726	7,494,957	8,228,063	8,133,571
Resins for all other uses	5,906,750	5,587,227	7,270,514	6,330,022
TOTAL	44,769,316	41,619,603	44,374,296	43,779,330
Vinyl and Vinyl Chloride Resins:[2]				
Polyvinyl chloride and copolymer resins (50% or more polyvinyl chloride) for—				
Film (resin content)		6,290,815		6,606,264
Sheeting (resin content)		4,454,684		4,204,742
Molding and extrusion (resin content)		15,441,360		15,747,702
Textile and paper treating and coating (resin content)[3]		4,512,353		4,828,825
Flooring (resin content)		4,340,504		4,812,067
Protective coatings (resin content)		2,287,582		2,285,463
All other uses (resin content)		3,600,105		3,801,149
All other vinyl resins for—				
Adhesives (resin content)		2,575,812		2,352,688
All other uses (resin content)		7,704,645		7,761,439
TOTAL	53,781,795	51,207,860	51,650,358	52,400,339
Coumarone-Indene and Petroleum Polymer Resins	18,323,510	18,404,461	19,159,530	19,051,034
Polyester Resins:				
For reinforced plastics	2,788,842	2,182,619	2,878,278	2,062,794
For all other uses	813,491	998,498	982,995	972,062
TOTAL	3,602,333	3,181,117	3,861,273	3,034,856
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1 4]	22,870,752	17,545,816	24,714,283	18,308,354
Protective-coating resins[5]	438,193	221,038	343,997	239,555
Resins for all other uses[6]	9,333,162	11,854,840	8,466,658	12,790,406
TOTAL	32,642,107	29,621,694	33,524,938	31,338,315
GRAND TOTALS	224,168,000	211,146,139	226,924,711	218,338,396

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, polyethylene, nylon, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, polyester, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.

SOURCE: United States Tariff Commission, Chemical Division.

NOTE—Sales of phenolic and other tar-acid molding compounds for 1954 should be revised to read 168,416,848 pounds instead of 186,416,848, as published in our May, 1955 issue.

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Current Market Prices

Price Changes and Additions

Adhesives

Thixons	gal.	$3.30 /	$9.00

Anti-Static Agents

Stabilite	lb.	.355 /	1.75

Catalysts

IC activators	lb.	3.00	
Inhibitor	lb.	.98	

Coating Resins

Synvaren 631	lb.	.17 /	.25
Synvarite BRLD	lb.	.39 /	.45

Colors

Acheson 0100 Series Paste Dispersions			
Blacks	lb.	.50 /	.81
Blues	lb.	.55 /	2.175
Green	lb.	2.51 /	2.69
Orange	lb.	.67 /	.85
Reds	lb.	1.08 /	1.34
White	lb.	.52 /	.70
Yellows	lb.	.57 /	.75
Harwick, blues	lb.	1.55 /	4.55
Brown	lb.	3.00	
Greens	lb.	1.55 /	4.50
Oranges	lb.	1.05 /	1.25
Reds	lb.	1.20 /	3.53
Yellows	lb.	.85 /	4.50
Interchemical IC Series			
Black	lb.	.56	
Blues	lb.	.75 /	2.10
Browns	lb.	.64 /	.69
Greens	lb.	.90 /	.99
Oranges	lb.	.78 /	.89
Reds	lb.	1.16 /	2.50
White	lb.	.70	
Yellows	lb.	.95 /	1.65

Fillers

Harwick clays	ton	14.00 /	57.00
Flock	lb.	.11 /	.28
Magnesia	lb.	.105 /	.13
Mica	lb.	.075 /	.0825
Pecan Shell Flour	ton	80.00 /	100.00
Stan White 325	ton	8.50 /	11.00
Walnut Shell Flour	ton	55.00 /	100.00

Flame-Proofing Agents

IC-776 Antimony Concentrate	lb.	.495 /	.51
M&T Antimony Oxide	lb.	.27 /	.285

Lubricants

HSC #35	lb.	1.36 /	1.48
IC-500	gal.	2.50	
-571	gal.	3.25	
-793-10	gal.	3.40	
Mold-Wiz	gal.	4.00 /	6.00

Molding Compounds & Resins

Polyester			
IC-312, -400, -514, -548, -625, -730, -800	lb.	.35 /	.385
-312-2	lb.	.365 /	.38
-336, -382, -706	lb.	.37 /	.385
-401	lb.	.44 /	.455
-420	lb.	.355 /	.37
-433	lb.	.38 /	.395
-636, -670	lb.	.48 /	.495
-638, -689	lb.	.55 /	.565
-670-2	lb.	.50 /	.515
-671	lb.	.405 /	.42
Filled resins	lb.	.255 /	.54

Plasticizers

Barrett iso-octyl-iso-decyl phthalate	lb.	.305 /	.345
Dinopol 235	lb.	.355 /	.385
MOP	lb.	.325 /	.355
Drapex 3.2	lb.	.40 /	.49
Elastex 60-A	lb.	.425 /	.465
Polycizer 162, 562, 662	lb.	.305 /	.335
332, 532, 632	lb.	.425 /	.455

Stabilizers

Stabelan E	lb.	1.35 /	1.50
HR, liquid	lb.	.65 /	.75
Paste	lb.	.85 /	.95
Powder	lb.	.95 /	1.05
HR-50	lb.	.75 /	.90
XL	lb.	.55 /	.65

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Literature upon request

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News of the Industry (Cont'd. from p. 309)

External Threads Available

With only a slight modification, the wire thread inserts manufactured by Heli-Coil Corp., Danbury, Conn., are being used to furnish external threads for the male member. The threads require no driving tang, and are coiled in manufacture to contract slightly on installation; this being the reverse of the regular inserts.

The new variation has been found useful in changing thread series. This situation often arises with foreign equipment, where Metric and Whitworth thread series are used instead of our standard National Coarse and National Fine. Other applications include salvage operations on worn or incorrectly-cut threads, and the providing of a thread in the middle of a shaft. In the latter case, threads can be machined into the shaft, and the flexible wire thread installed without reducing shaft diameter.

Globe Switches to PVC Pipe

A major distributor of acids, solvents, and corrosive chemicals, Globe Chemical Co., Cincinnati, O., is completing a changeover from metal to PVC piping for all services. Globe formerly employed carbon steel, wrought iron, Types 304 and 316 stainless steel, and aluminum pipe which required replacement at 3-12 month intervals.

PVC piping was fabricated with unplasticized, injection-molded screwed fittings by Tube Turns Plastics, Inc., Louisville, Ky., and installed at Globe's tank farms and loading facilities. The pipe conveys 77-96% sulfuric acid, 61.4% nitric acid, 37-38.5% muriatic acid, 75-85% phosphoric acid, and 99.5% glacial acetic acid. Temperatures are atmospheric, and pressures do not exceed 100 psi.

Hose Triples Water Output

A new Koroseal garden hose designed for open-end use by professional gardeners has been introduced by B. F. Goodrich Co., Industrial Products Division, Akron, O. Designated Professional Gardener's Hose, it reportedly delivers 3-4 times as much water per minute as regular garden hose, owing to its ¾-inch inside diameter.

The bright green hose has a 16-sided exterior and heavy-duty brass couplings. Intended for low pressure systems, the hose is available in 25-, 50-, and 75-foot standard coupled lengths, and in uncoupled lengths up to 300 feet.

Synthetic Products Expands

A 30,000-square foot addition to its manufacturing and warehouse area is now under construction at Synthetic Products Co., Cleveland, O. The expansion was reportedly required to handle the company's increased production of vinyl stabilizers, stearates, and specialties.

The stabilizer division, which markets products under the trademark Synpro, has simultaneously announced an expansion of their technical service department. Raymond J. O'Hara, as chief chemist, directs the operation.

Vinyl For Fumigation Covers

Better quality tobacco leaves are being grown through the use of pre-growth soil fumigation, a process which utilizes huge sheets of flexible vinyl plastic. B. F. Goodrich Chemical Co. supplies the Geon vinyl sheeting which is marketed by Electro Plastics Fabrics, Inc., Pulaski, Va.

Dirt is piled around the outer edge to obtain a tight seal with the ground, and methyl bromide gas is piped under the covering. Within 24-48 hours, the seed bed is entirely free of weeds, insects, and soil organisms. The 100-square foot cover can be reused many times, being impervious to the gas, as well as resistant to weather, moisture, and chemicals.

Molds Acrylic Percolator Knob

Acrylic has replaced glass in the coffee-percolator knobs molded by Westinghouse Electric Corp., Pittsburgh, Pa. It was found that miniature cleats could be molded into the knobs in a diagonal pattern which engages the percolator shell more effectively than does glass which resists attempts to mold-in such fine detail.

In addition to being chip- and break-proof, the knobs are non-conductors of heat, thus affording comfort to the touch. The knobs were developed by Nosco Plastics, Inc., Erie, Pa., by injection-molding the parts from Plexiglas V in an eight-cavity mold. Economical to produce, the knobs have a heat distortion temperature of 189-213° F., which is sufficiently above the 162° F. brewing temperature of the Westinghouse percolator.

Atomic Exposition Planned

Floor plans, regulations, and space applications for the world's first major Atomic Exposition at the Public Auditorium, Cleveland, O., December 10-16, have been distributed to more than 300 companies who so far intend to exhibit, according to Athel F. Denham, director of the event.

The affair is being sponsored by the American Institute of Chemical Engineers, and will be held in conjunction with a Nuclear Congress in which 22 business and technical organizations, with a membership of more than 400,000, are participating.

Information and applications may be obtained from the International Atomic Exposition, 931 Book Bldg., Detroit 26, Mich.

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CALENDAR of COMING EVENTS

June 24
Detroit Rubber & Plastics, Annual Outing.

June 29—July 1
ASTM Committee D-20 on Plastics, Chalfonte-Haddon Hall, Atlantic City, N. J.

September 6
SPE Southern California Section, Scully's Restaurant, Los Angeles, Calif.

September 21
SPE New York Section, Gotham Hotel, New York City.

September 28
Reinforced Plastics Group, SPE New York Section, Tufaro's Restaurant, Corona, N. Y.

September 29
Fort Wayne Rubber & Plastics Group, Van Orman Hotel, Fort Wayne, Ind.

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